

June/July 1986

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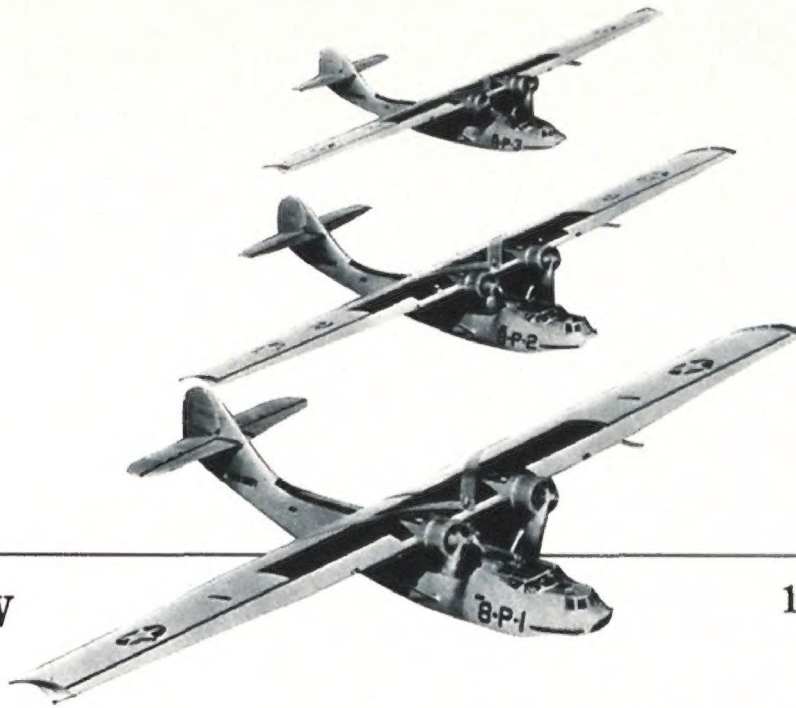
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by Joan Feldman

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cover: *Bryan Allen and the White Dwarf pedal-blimp were photographed in the air over Oshkosh, Wisconsin, by James Sugar/Black Star.*



A Decade to Dream On

This issue of *Air & Space* coincides with the tenth anniversary of the opening of the new National Air and Space Museum. On July 1, 1976, we sent a signal to a Viking spacecraft approaching Mars, which bounced the signal back to the Museum. It activated a Viking Lander arm that snipped a ribbon to admit our first visitors. Almost ten million people followed that opening-day crowd during the first year, and by July 1, 1986 almost 100 million people will have shared the NASM experience.

The Museum's first decade has been marked by a host of advances and fundamental changes in air and space. For example, when President Carter signed the Airline Deregulation Act on October 24, 1978, he ushered in a wild time of \$200 coast-to-coast flights, no-frills airlines sprouting like crocus shoots, and airports jam-packed with travelers who used to take the bus. In the 1980s, the geostationary orbital arc 22,000 miles above Earth has become so crowded with communications satellites that countries are competing for rights to its slots. We are well on the way to becoming a global village.

Aviation achievements included a demonstration that human-powered flight is possible—Bryan Allen, pedaling Paul MacCready's *Gossamer Condor*, won the Kremer Prize in August 1977 for being the first to fly a mile-long figure-eight course. And in December 1978, Englishmen David Williams and Fred To piloted the first solar-powered aircraft, *Solar One*.

In space, a global race to send widely diverse craft to the ends of our solar system and beyond picked up speed. In 1977, the United States launched *Voyager 1* and *Voyager 2* on a "grand tour" of the outer planets—Jupiter, Saturn, Uranus, Neptune, and Pluto—with spectacular results. The space shuttle program took off on April 12, 1981, with the launch of *Columbia* on a two-day mission. This year, spacecraft launched by Japan, the Soviet Union, and the European Space Agency rallied near Halley's comet for a long, close look.

Rather than simply cataloging objects and events, we at the Museum like to use past accomplishments as guides for the fu-

ture. We're already looking forward to our twentieth anniversary, which should give us the chance to celebrate the passage of many new milestones in air and space. With the government's recent launch of its massive program to develop an "aerospace plane," and a report due from the National Commission on Space on what America should be planning for the next 25 years in space, our next decade is already off to a busy start. The explosion of the *Challenger* early this year, and the national debate that it triggered about our goals in space, will of course influence the course of near-term events. But I'm confident the course will lead ever upward.

Although aviation, space flight, and their related fields provide excitement for millions of people in all walks of life from all corners of the globe, it is perhaps curious that air and space artifacts by themselves do not have a universal attraction. Row after row of airplanes are to most people only . . . well, row after row of airplanes. The Museum's appeal lies in making these wonderful icons meaningful to everyone by fitting them into our view of history, our social fabric, and our political and intellectual life. Being able to see the Apollo 11 Command Module in the Museum gives visitors texture for an unforgettable memory.

Air & Space is intended to reach out to people in the same way. The magazine is not about the Museum, but it is of the Museum, an extension of its methods and philosophies, a reflection of its standards and its dedication to accuracy. Nothing related in any way to air and space—vehicles, animal life, personalities, philosophy, memoirs, speculation on the future—will be overlooked. There will be articles for everyone—novice, buff, or scholar—all designed to reflect the great happenings of the past and the enormous promise of the future. And *Air & Space* will not avoid controversial subjects, but rather will embrace them with informed presentations.

Air & Space intends to be not only a chronicle of one of the great experiences of our era—flight—but also a new adventure in itself. Take off with us on this adventure.

—Walter J. Boyne

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Letters

Premier Issue

The premier issue came into my hands today and I hasten to send you warmest congratulations. Editorial excellence, pictorial excitement, and a lovely balance of subject. The magazine fills a need and all of you should feel very proud.

Willis Player
Murrieta, California

I must say how impressed I was with the diversification of articles and high standards of writing. As an active professional pilot for over 23 years, during which time I have read many aviation trade publications, I feel qualified to say, "This is aviation's finest."

Jim L. Shamp
Fresno, California

Slick, is how it turned out. Here I expected *Air & Space* to leave me in a high-tech funk, and instead you grabbed me with the biplane cover and carried me skyward in a Sopwith Camel. Thank you!

John Mack Carter
New York, New York

Write, Sally Ride

I was particularly moved by "Single Room, Earth View." I have read fewer than half a dozen [writers] who can tell us in plain language what it is like to fly: Saint-Exupéry, Langewiesche, Lindbergh, Gann, and now Sally Ride. I'm going to save that one.

Hu Stock
Pueblo, Colorado

Limited Space

The first issue of *Air & Space* was technically well done, as one might expect of the Smithsonian Institution. However, the relative emphasis given to air and space subjects was distressingly unbalanced. Those of us who are interested primarily in space rather than in aircraft hope that this is a

temporary phenomenon, and that *Air & Space* will not become just another airplane hobbyist's magazine.

Michael A.G. Michaud
Bethesda, Maryland

Close Encounter

In George Larson's "Picture Your Ad Here," he says the origin of the word "blimp" remains shrouded in mystery. If any old artillerymen from World War I read your article they will be quick to point out that the tethered gas bags containing an artillery spotter suspended in a basket below were designated officially by the army as "B-Limps."

After the war when the last B-Limp had been reeled in, non-rigid ships or "Limps," as compared to rigid dirigibles, became known as blimps.

Gerald G. Walker
San Francisco, California

I remember when my father took me to see the arrival of the *Graf Zeppelin* in the United States in October 1928. Thomas A. Lewis's "Cathedrals in the Sky" gave me that familiar old chill as I, too, looked up to see "emerging from the clouds," that giant. The steady hum of its engines broke the awesome quiet as it drifted overhead, and as a youngster, I thought I had felt the brush of another planet. I look forward to every issue of the magazine. Thank God, someone at last is recognizing the tremendous wealth our country has in its aviation and space history.

Midge Sherwood
San Marino, California

Royal Mix-Up

Your first edition recently arrived in my lounges and was read avidly by my guests. I have to tell you that their reactions were entirely favorable. Your magazine is a success and is destined for a golden future.

It was particularly rewarding for me to

find myself mentioned in the caption on page 28. After so long in retirement at my Long Beach retreat, it was good to know that I am remembered. Alas, I fear that the picture itself portrays a younger member of the family. I must confess that I never had such a trim figure and I believe I smoked rather more than *Queen Elizabeth II* could ever do from her single funnel. Unfortunately, it is also true that I did not remain a transatlantic traveler long enough to share the experience with the Concorde and the Red Arrows.

On the bright side, I see that page 28 also draws attention to the value of such inadvertent errors. If an upside-down aeroplane can become worth \$110,000, how much more should it be possible to get in due course for a caption which identifies one royal personage as another?

Signed on behalf of *RMS Queen Mary*.
Air Vice Marshal Ron Dick, R.A.F.
Washington D.C.

Mystery Walkers

Congratulations on your first issue. It's beautiful and so engrossing I sat down and read it, cover to cover. I have only one problem. What in the world are those two Russian "fuselage walkers" doing on the *Il'ya Muromets* on page 116?

The article and the rest of the magazine are utterly fascinating but that question will bother me for some time.

Brent Stark
Veradale, Washington

According to Von Hardesty, who edited the English translation of K.N. Finne's Russian Air Heroes of I.I. Sikorsky, the walkers in question could be helping balance the aircraft to keep its nose up during landing, or may be making their way to the observation platform in the rear. A definitive answer is probably lost to history.

War Paints

What an unheard-of idea to run an article on the Imperial War Museum without a single photograph! The water colors by Paul Salmon are beautiful.

Steve Milliken
Upper Black Eddy, Pennsylvania

Air & Space welcomes comments from its readers. Letters must be signed and may be edited for publication. Address letters to Air & Space magazine, National Air and Space Museum, Smithsonian Institution, Washington, D.C. 20560.



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Dark Flight

Night settles in as we walk across the tarmac to the waiting Blackhawk, a dull orange sky burning out to vague purples and blues—still too much light for what we are going to do. On the U.S. Army's airfield here at Fort Campbell, Kentucky, row after row of helicopters stand silhouetted against the lingering glow. A chopper is a skeletal thing when shut down. Rotors sag under their own weight, struts protrude like pipework, and the whole thing looks awkward and fragile. A chill wind grabs at us. Night-vision goggles—NVGs—hang around our necks, with lenses protruding on prongs. There is no moon.

We clamber into the metal hulk and strap in with heavy nylon webbing. The two pilots run through their checklists and the turbines start a rising whine. I put on my headset: the high frequencies from a turbine will take a notch out of your hearing profile, which is why so many helo pilots are half deaf. The whine rises, gathering force. The ship shakes as the blades slowly come around—*whunh! whunh!*—picking up speed. We're trapped in the strange sensory isolation of a chopper at night: seeing nothing but the residual sunset, sense of touch numbed by the *jigglejigglejiggle*, hearing only a complex whine and mechanical voices over the headset.

Our goggles are "microchannel photo-multipliers," common night-vision gear because they are both reliable and reasonably cheap. The military uses them because it believes that future wars will be fought in large part at night. They consist of thousands of little glass tubes of microscopic diameter, pointing forward from the eyepieces. When a ray of light enters one of the tubes, it knocks electrons from the sides, which knock off more electrons. The cascade of electrons exits the tube and hits a phosphor screen, causing it to glow. The picture seen by the person wearing the goggles is made of countless such glowing points from all of the tubes.

After the usual chatter with the control tower, we lift off and begin drifting over the tarmac at an altitude of three feet. The pilot adds some pitch to the rotor blades, and the Blackhawk hops into the sky like a star-

tled jack rabbit. This newest Army utility transport helicopter is not under-powered: you feel the upward acceleration in your stomach.

I put on my NVGs—with spectacular results. For a moment it seems as if the pilot has turned on the cabin lights. The helicopter becomes a green-lit room bright enough for reading a map. The pilots ahead in the cockpit, entirely invisible before, now look normal except for strange rods protruding from their eyes—pale green pilots, one with a pale green mustache, all flickering slightly like a grainy television picture. Resolution with the goggles is adequate, but not great. I'm told, however, that newer goggles now being issued to aviators—third-generation passive image intensifier devices, in the argot—provide a much clearer view. The instrument lights gleam brightly on the console. The Blackhawk's

instrument panel has a dimmer control that drops the light level to a point invisible to normal vision but plenty bright to the goggles. Ordinary panel lights would overload NVGs and blind them.

Beyond the windshield huge glowing orbs hang: streetlamps, I think for a disoriented second. Actually, they are stars in a faint overcast. To the goggles, a star is a very bright light.

Intercom chatter continues. "Scrrree—ah, roger that . . . cleared for three-niner." We are over forest now, and the tower is careful to track where we are going. Blacked-out flight presents serious problems of safety. Other aircraft cannot see us at all once we turn out the running lights. In the green television world of goggles, we would be able to see them only at reduced range. The Army does not want invisible helicopters closing on each other at

See-in-the-dark goggles turn helicopter pilots into hawks.



US Army



The NVG's picture comes in one color—green—but provides rich detail.

a combined speed of 200 knots—about 230 mph. The results, our pilot comments laconically, would be “not too good. Bad, you might say.”

We reach the range, miles and miles of woods. “Okay, troops, we’re going operational,” says the pilot, a slow-talking fellow from Tennessee. In military talk, any unit under normal control is “administrative.” When it goes “operational,” usually to simulate combat, the ordinary rules quit and things sometimes get wild. My stomach rises toward the rotors as we drop toward the forest, banking hard left. I look out the window. Trees are racing past the landing gear, pouring by like a river of groping fingers—a mixed metaphor, but exactly how it looks. We seem to be about a foot from the upper branches.

This isn’t true, of course—pilots may be a little crazy, but not that crazy. The trouble is that the goggles distort perspective and destroy depth perception. I squeeze my talk switch and ask how much trouble the distortion causes. (Talking on an intercom is a peculiar business. There is no sense of direction, all voices seeming to come from the middle of your head, and you can’t even be sure the voice is in your aircraft.)

“Yeah, you do have that problem, sure do. You can’t just put these things on and go flying. I mean, not if you want to come back. But, see, you can sort of make your own depth perception—you know, move

your head and see how things move relative to each other and all. It’s not bad when you get used to it.”

The pilot speaks in a relaxed drawl as if he were sitting in his living room, an odd thing if you think about it. We are sailing through the night in a whining, jiggling racehorse of a helicopter, looking like martians from some horror movie or teenage nightmare, the world turned to sparkling two-dimensional green—and this guy is acting as if it were a reasonable thing to do. The military is funny that way.

Both pilots turn their heads slowly back and forth, mechanically and ceaselessly. The goggles provide only a narrow field of vision: 40 degrees. If you don’t scan back and forth, you can run smack into anything coming from the side. The Army, I learn, has tried to develop goggles with an expanded view, but “the human-factor guys found that they don’t work. All that sensory input turns out to confuse pilots when they’re flying.”

The NVGs have other problems, too. They respond especially to infrared light, which means there are certain things—dead trees and telephone lines, for example—that they don’t see well. This fact acquires considerable importance at 100 mph.

“Okay, Jack, you wanna set her down?” says that relaxed sitting-on-the-front-porch voice. The purpose of the flight is to refamiliarize the copilot with goggles, which

he has not used for some months. Out the window a clearing is visible, a small hole in the floor of the foliage. We settle toward it.

“How’m I doing?” the copilot asks casually, mustache sparkling green.

“Purty . . . real purty” says the pilot, watching carefully. This pilot is not as casual as he seems. The wheels thump down. “Bee-yootiful! Somebody give the nice man a see-gar.” We have just landed this howling bird in pitch, blind, absolute darkness. Give the man a see-gar.

After a half-dozen touch-and-goes, Tennessee says, “Guess we’ll just drive around a while,” and we take off across the woods fast and low. I think they just want to show what their machine can do.

The forest becomes a billowy sea. A few tall trees poke up like ghostly towers, and squadrons of leafy trees rear before us in puffs of foliage with seams in between. Good pilots fly the seams to stay invisible.

We streak into that infinite pale-green video game, banking away from the high growth. Trees take shape in the distance, quickly heave up from the surrounding sea, and . . . agh! . . . whip past the ship to be replaced by others.

“How fast we going?” I ask.

“Oh, about 80 knots. You gotta take it easy down close to the bushes.” Same calm voice. People are curious creatures; the third time they do anything, no matter how improbable, it is just life as usual. For the Blackhawk, with a top speed of 193 knots, 80 knots really is taking it easy. If it doesn’t hit a tree.

I glue my face to the window and look down. The forest floor is stored for blurred microseconds by the retina so that I see things in snapshots. Trees converge toward the earth like spines of some gigantic sea urchin. Patches of swamp gape at us, utterly black: water does not show up at all in the goggles.

Low-level in a chopper is giddy. Helicopter guys delight in giving rides to fighter pilots, who think they are the world’s preeminent macho men. After screaming along some gully looking up at the surrounding foliage, they are imminently ready to return to something comparatively sedate, like flying fighters.

Fuel finally runs low. We go administrative, turn on the running lights, become visible, and head for the airfield.

In an hour the Blackhawk will be shut down, ticking quietly as it cools. Its riders, we reformed bug-eyed monsters, will be at the officers club, drinking beer in sports shirts and talking about football. When you deal with the military, the transitions can be stranger than the flying.

—Fred Reed

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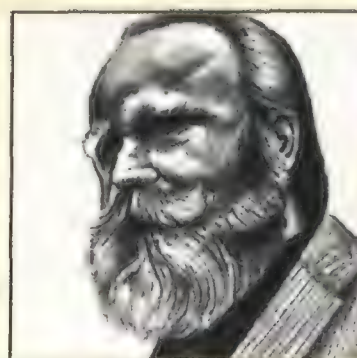


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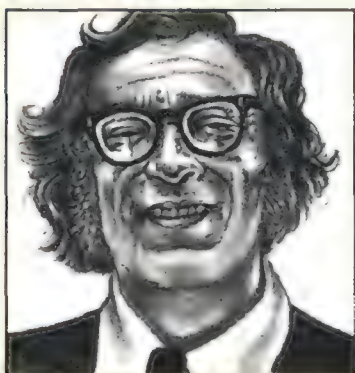


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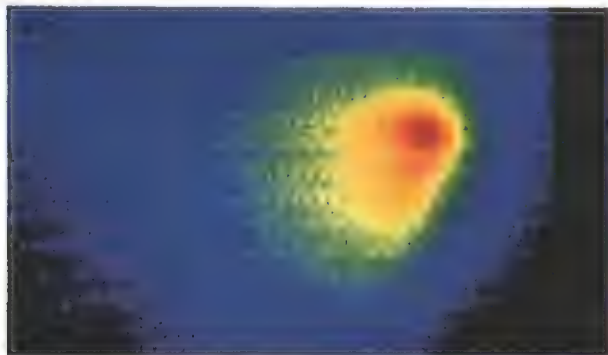
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Comet Hunting, Soviet Style

Hardly anyone jumps at the chance to experience winter in Moscow. Yet in March scores of planetary scientists from around the world, as well as a contingent of U.S. journalists, did just that. The lure was Halley's comet, but not because it shone brightly over the city's skyline. Two Soviet spacecraft were about to plunge headlong

SOVFOTO



into this infrequent cosmic visitor to try to catch the first-ever glimpses of its icy heart.

The control center for the operation was the Space Research Institute, a branch of the Soviet Academy of Sciences. Better known by its Russian acronym IKI, the institute is one of the few facets of the Soviet space program with any real visibility outside the country. IKI's director, Roald Zinnurovich Sagdeev, is considered both a first-rate plasma physicist and a savvy manager. Since his arrival 13 years ago IKI has created a wide-ranging series of successful spacecraft.

The mission to Halley's comet came about more by fortuitous afterthought than by grand design. In 1981, two identical spacecraft were being built for a flight to Venus, where they would deliver balloon-borne atmospheric probes and instrumented landers. But Sagdeev and his scientists soon realized that by flying past Venus instead of staying in orbit there, the craft could swing around to intercept the comet as it left the inner solar system.

The switch caused a scramble to instrument the probes for comet work, and Sagdeev drew heavily on an Eastern-bloc space alliance known as Intercosmos. During the transformation the spacecraft also picked up a new name: *Vega*, a combination of the Russian words for Venus (*Venera*)

and Halley (*Gallei*). Rushed to completion, the twin probes left Earth in December 1984, made their deliveries at Venus the following June, then headed for a date with Halley nine months later.

The first encounter occurred the morning of March 6, timed so that the spacecraft could be tracked by a giant antenna in the Crimea. Besides its powerful cameras, *Vega 1* carried several devices to determine the comet's composition and four dust detectors. (Although Soviet officials did not acknowledge it publicly, two of these were built by U.S. scientists and quietly added to the payload by Sagdeev.) The spacecraft had little in the way of special shielding, yet it suffered only minor damage as it streaked—at 49 miles per second—toward the comet's core.

The cameras remained glued on their target, sending back fresh pictures every few seconds. Nine minutes later the images reached the institute and were immediately flashed onto huge viewing screens. Though reminiscent of a National Aeronautics and Space Administration production, there was no doubt that this was a Soviet affair: the running scientific commentary was in Russian and the data printouts were in the Cyrillic alphabet.

The scientists at IKI were divided on whether any of the images showed a clear view of Halley's nucleus—it was a particularly dusty time to fly through, as it turned out—but they were otherwise elated with the probe's performance. And with one "dive" completed, they confidently looked forward to *Vega 2*'s encounter on March 9.

Things were fine with the second spacecraft until the pointing system controlling the cameras malfunctioned shortly before passing the nucleus. Quiet panic raged for a few anxious minutes in the experimenters' area. With time running out, they beamed a last-ditch corrective command to *Vega 2*. It worked, to everyone's great relief, and soon thereafter proud scientists were passing out glossy Polaroids of Halley's nucleus as if they were snapshots of a newborn infant.

Sagdeev took obvious delight in all of this. He freely courted attention from American reporters on the scene and

shoved the project's key players into the media spotlight. And why not? It was a glorious technical and scientific accomplishment to be shared with all the world.

—J. Kelly Beatty

A National Attraction

At virtually every major airport—and at many smaller ones—controversies rage over noise pollution inflicted on nearby communities. Vociferous groups protest nighttime landings, daytime landings, and simply the presence of the airport—which has usually preceded its opponents.

However, a silent minority—probably those who do not live under the flight paths—view their airport as a Sunday park. A prime example is Washington's National Airport, which every sunny weekend becomes a recreational spot for the locals. At Gravelly Point, a park along the banks of the Potomac River and a stone's throw from the end of the runway, you must arrive early if you want to find a parking space. Here, sailors launch their boats, soccer teams compete, yuppies jog, fishermen doze on the rocks at river's edge—and families come by the station wagon-load just to watch the airplanes.

Children squeal with delight as the airplanes thunder overhead, while parents cringe and cover their ears. Some devotees carry radios tuned to the airport tower, and a curious crowd gathers around them to hear airline pilots preface every transmission with the traditional, "And, uhhh. . . ." (Do not mistake this for a hesitation—it is delivered in the standard growling cadence that marks the veteran captain, or more often, the aspiring veteran copilot.)

When the wind is out of the south, the arriving airliners delicately thread their way down the Potomac to avoid flying directly over the city and its suburbs. Because the runway is fairly short—6,869 feet, compared with 11,500 feet at nearby Washington-Dulles—the Boeing 757 is the largest aircraft accommodated here. With its spindly landing gear feeling for the runway, it resembles a huge aluminum heron closing in on a hapless fish. (Eastern's enormous

"757" logo on the tail is surely the world's largest designer label.) Other regulars include the chunky Boeing 737, which looks like a young and overfed 727, while the stretch DC-9—with its long, tapering fuselage and impossibly tiny wings—is more of a missile than a commercial airliner.

Most of the 1,200 aircraft arriving and departing daily are large airliners, but occasionally a four-seat Piper Cherokee 180 or a Cessna 172 whistles down the approach

Illustrations by Paul Salmon



path, its occupants waving to the crowd under its wings. And sleek corporate jets—Lears, Falcons, Gulfstreams—streak past hovering police helicopters.

The commercial jetliners fly so low over the park that "you can just about reach out and touch them," says Dave Hess, public-affairs spokesman at National. Indeed, you can gauge the priorities of each airline by the underbellies of their airplanes as they approach the runway—some are a blinding silver or white; others are oil-streaked and fully in need of a wash and wax.

Lessons in aerodynamics abound. Spectators judge landings by the amount of gray smoke created as tires touch runway. And when the wind is just right, the aircraft dramatically demonstrate the power of wing-tip vortices, created when air eddies off the wing tips and swirls down to the grass, invisible but as loud as nylon sails luffing smartly in a brisk sea breeze. The sound baffles most onlookers, who search in vain for the source of the ghostly zephyrs that are heard a good ten seconds after the aircraft has passed overhead.

The lure of the local airport is felt across the country. At Westchester County Airport in White Plains, New York, airport spokesman Joel Russell says, "We're searching for a park for people to use to watch the traffic here. Right now all we have is a small picnic area, which fills up on

weekends." At Stapleton International Airport in Denver, Colorado, "people enjoy the airplanes and a tremendous view," says public-affairs spokesman Richard Boulware. At Hartsfield International Airport in Atlanta, Georgia, "people bring their kids just to enjoy the fun terminal we've got—they love to ride the shuttle trains," says John Braden, director of public relations. And at Dulles, "the Concorde is always a drawing card," according to Kathy Thomas, assistant to the airport manager.

Small airports hold charms as well, particularly in their restaurants or snack bars, where you often will find the best country breakfast in town. At Montgomery County Air Park in Gaithersburg, Maryland, visitors waddle out to the flight line after a stack of pancakes, sweet butter, and maple syrup, and promptly fall asleep in the sun.

You'd think that today's generation, raised on moon shots and shuttle launches, would be inured to the everyday comings and goings of aircraft. Some are. But if you travel the perimeters of any airport in the country, you'll always find someone just watching the airplanes. And if you want to spend an afternoon doing that at Gravelly Point, remember to arrive early.

—Patricia Trenner

Spitfire: Keeping the Legend Alive

The Spitfire, considered by many to be Britain's greatest World War II fighter and one of the most beautiful airplanes ever built, recently celebrated its golden anniversary. On March 5, 1936, test pilot J. "Mutt" Summers inaugurated the Spitfire legend when he took the prototype aloft from Eastleigh Airport, located on the southern coast near Southampton, for a 15-minute flight.

The legend crystallized four years later, during the dark days of the Battle of Brit-

ain. As Royal Air Force pilots fought over their homeland against hordes of Luftwaffe attackers, the Spitfire came to epitomize England's indomitable wartime spirit—for those on both sides of the Channel. When Hermann Göring asked a number of his Luftwaffe commanders in 1940 what their squadrons needed, Adolf Galland was not diplomatic. "I should like a squadron of Spitfires for my group, Herr Reichsmarschall," he reportedly replied.

But the Spitfire owes its immortality almost as much to its pleasing shape as to its war record. The fluid curves of its wings and its slim fuselage made the airplane a winning combination of aesthetics and aerodynamics. But the Spitfire's looks could kill.

As proof of the fighter's continuing appeal, Britain's Spitfire Society rounded up sufficient support to commemorate Mutt Summers's brief but portentous flight. Unfortunately, the unabashed exercise in nostalgia at Eastleigh was dampened somewhat by the local weather and the collapse of the landing gear of the first Spitfire to arrive for the informal ceremony.

This combination of events closed the airport until early afternoon. But after weather and runway had cleared, three carefully restored Spitfires teamed for a flyby over the field and the former Vickers-Supermarine factory at Woolston, where the airplanes were built.

The festivities attracted the two test pilots who had been most involved in the airplane's development and production, Jeffrey Quill and Alex Henshaw. Quill, now in precarious health, was the only person present who had witnessed the first flight. Also present were several well-known R.A.F. pilots and Gordon Mitchell, who was just 16 when his father, Spitfire designer R.J. Mitchell, died in June 1937.

In the decade of the Spitfire's production, British assembly lines churned out more



than 20,000 of the airplanes. Approximately 170 survive in some semblance of preservation, although only about 25 are in flying condition. However, increasing efforts to preserve the legendary fighter have prompted a British company to gear up to produce new structural components badly needed by restorers.

Unfortunately, the company can't help with the overhaul of the Rolls-Royce Merlin engines, forcing restorers to turn to specialists in the United States. And in an ironic twist, most Spitfires today rely on wooden Hoffmann propellers, which are custom-made in West Germany.

Yet even with German propellers, the Spitfire's evocative silhouette and the booming song of its engine still serve as poignant reminders of the valiant defenders during the Battle of Britain. As Winston Churchill said in tribute, "Never in the field of human conflict was so much owed by so many to so few."

—John Fricker

Thai in the Sky

It began with a bang and ended with a bang—literally.

Thai Airways International recently held its annual Marketing Activity Plan conference—MAP '86—in Pattaya, Thailand, a beach-front resort about 80 miles southeast of Bangkok. About 350 of the airline's employees from around the world, 50 journalists (mostly from Asian travel and business publications), and 100 Thai government officials, including Prime Minister Prem Tinsulanonda, attended.

Delegates were welcomed with the news that a small fire had broken out earlier in

the day in the hotel hosting the conference. Only gradually did it emerge that the fire was caused by an explosion, and that the source of the explosion was an untended suitcase. The fact that the prime minister was to arrive later in the day and that the government was embroiled in a controversy over whether to retire the commander of the armed forces may have been mere coincidence.

In any case, the prime minister arrived on schedule—accompanied by a phalanx of bodyguards and soldiers—and the next morning he officially opened the conference. Then after a brief performance by traditional Thai dancers and musicians, things got rolling.

Despite its name, MAP '86 did not deal exclusively, or even primarily, with marketing. Granted, a preliminary version of the 1987 Thai Airways advertising campaign was unveiled, but for the most part the meeting served as a combination board meeting, pep rally, and seminar on international tourism. It also provided an inside look at the workings of a unique airline.

If an airline can be said to have a personality, what makes Thai's unique is its integration of the country's traditions into everyday business operations. For example, when a new aircraft is added to Thai's fleet, ceremonially garbed elephants pull the airplane out of the hangar, Buddhist monks bless it, and the king of Thailand gives it a mythological name. The queen designs the uniforms that flight attendants wear.

It must work, for Thai Airways boasts an international reputation for exceptional service and has built an impressive profit record. Its financial picture improved from a loss of about \$1 million in 1960-61 to a profit of \$5 million in 1974-75. Profits leveled off, and even dipped slightly, in the late 1970s, but they jumped to a record \$25 million in 1983-84.

Perhaps buoyed by this success, an atmosphere of joviality prevailed throughout the meeting. One of the first speakers was James Worsham, president of Douglas Aircraft Company at McDonnell-Douglas Corporation—which seemed a bit odd, since all the aircraft in Thai's fleet are built by Boeing or Airbus, a European consortium based in France. Not surprisingly, Worsham gave an aggressive sales pitch. And, not surprisingly, Boeing and Airbus executives later defended their products vehemently. But a metaphor injected by the Thai moderator best captured the mood of this professional jousting: "Maybe our air fleet can be like an American sandwich, with Boeing and Airbus as the slices of bread, and McDonnell-Douglas providing the filling." Then everyone wanted a bite:

the General Electric Aircraft Engine Group representative suggested that his company provided the toothpick holding the sandwich together, another executive claimed his firm was the mayonnaise, and so on.

But undoubtedly the most memorable speech was given by the deputy minister of industry, Mechai Viravaidya. He began by pointing out that 90 babies would be born in Thailand during his 30-minute speech—although a digression, it was an appropriate opener for a man who has won acclaim for helping reduce Thailand's birth rate by about half over the past two decades. On the subject of aviation, he outlined a rather unorthodox plan for how the airline could win both new international travelers and increased respect from the average Thai citizen. "I want the small farmer, who will probably never have a chance to fly on Thai, to feel proud of Thai," he said. "When the price of pineapple falls, Thai should hand out pineapples to all its customers. Not only will you make your customers happy, you will also help the pineapple farmers find a market for their product."

MAP '86 was hardly a nine-to-five affair. On opening day every delegate received a wake-up call at 4:30—that's 4:30 a.m.—to make sure that no one slept through a six o'clock "Charity Walkathon" with the prime minister.

Dinner that night was held at the "Elephant Kraal," a farm that raises and trains performing elephants. Most of the pachyderms slept through the festivities, but a few did cooperate, if only briefly.

A gourmet buffet served on an outdoor terrace overlooking the Gulf of Thailand marked the close of MAP '86. Music and dancing followed. And just as the evening was winding down, there came a loud sizzling sound and a few pops, as smoke billowed around scaffolding at the edge of the terrace. As the smoke cleared, the scaffolding emerged, now a billboard of slow-burning fireworks that spelled out "Thai" and "MAP '86," and depicted the airline logo. Dozens of fireworks burst overhead.

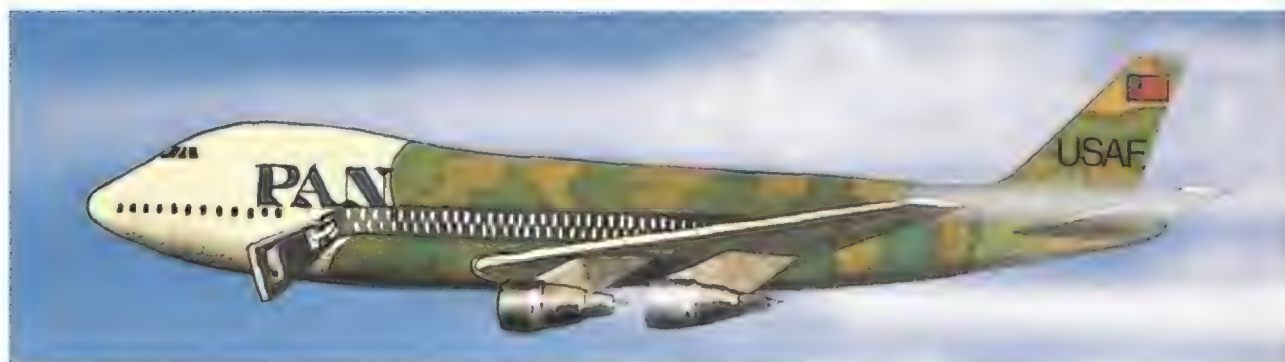
Way to go, Thai—not with a whimper, but a bang.

—Katie Janssen

Warriors Flying Standby

When Pan American's *Clipper Sea Serpent* touched down at New York's Kennedy International Airport one recent Saturday night after a routine flight from London, it wasn't restocked with food, booze, and honey-roasted peanuts for another hop across the Atlantic. Instead, the Boeing 747 rolled into a waiting hangar and ground crews swarmed aboard to remove 379





seats, lavatories, galleys, overhead movie projectors—everything.

The airliner had been drafted. With Uncle Sam paying the bills, it was converted into a freighter and spent two weeks carrying military gear. After earning its stripes, the jumbo jet was transformed back into a civilian carrier. But like some superhero who always wears his outfit under his street clothes, the 747 retained a few structural modifications so it can be quickly re-converted during a national emergency.

The *Clipper Sea Serpent*'s conversion, which some observers likened to changing a civilian living room to a military garage and back again, tested one strategy that the Air Force is using to overcome its shortage of airlift capability. Under the Civilian Reserve Air Fleet (CRAF) program, the Department of Defense has standing agreements with several airlines to requisition airplanes in times of crisis. But as good as the jets would be for moving troops, they can't handle heavy cargo loads such as trucks. Thus Pan Am has agreed to "enhance" 19 of its 747s. After stripping each aircraft's interior, Boeing Military Airplane Company, the Wichita-based firm modifying the aircraft, reinforces the walls and floors with steel and adds a cargo-handling system with rollers that ease loading and unloading. Except for a new door built into the left side of the fuselage, the military alterations won't be noticeable to passengers.

Pan Am will receive \$30 million apiece for allowing the modifications of its jumbo jets, all of which are scheduled for completion by 1988. "It would cost the Air Force almost six times as much to purchase and operate a similar fleet," says Lieutenant Colonel William Ritchie, spokesman for the CRAF. Because the enhancements add 13,000 pounds, the Air Force will pay Pan Am for hauling the extra weight during the flying life of each aircraft.

The *Clipper Sea Serpent*'s change from civilian carrier to military freighter went smoothly: the job took only 36 hours instead of the projected 48, says Richard Acquavita, Pan Am's jetport maintenance chief. Once ready for duty, the airplane voyaged to California, where it picked up 60 tons of cargo and headed for Osan, South

Korea. Although under an Air Force contract, Pan Am crews manned the cockpit.

For the next two weeks the airliner flew military missions across the Pacific in support of joint American-Korean "Team Spirit" exercises. Jeeps, cargo, and troops occupied the same space that held business people and tourists days earlier—prompting some wags to speculate about how many frequent-flier bonus miles Pan Am would award the members of the California National Guard who tagged along on the *Clipper Sea Serpent*.

—John J. Metzler

Along for the Ride

Thomas Lang has played a vital role in the safe flight of hundreds of aircraft in his job as an air traffic controller. Yet his view of the intricacies of flying is limited, he readily admits, because he is not a pilot.

Lang isn't alone. "Ten years ago, at least half of the controllers were pilots," says Patricia Weil, director of communications at the Aircraft Owners and Pilots Association (AOPA). "Now, it's probably somewhere around ten or fifteen percent."

This situation has generated alarm in general-aviation circles—725,000 pilots and 221,000 non-airline aircraft—where complaints are frequently heard that controllers and pilots aren't communicating well. (Relations between the two groups are strained by an inherent and perpetual debate on who has control over what.) A key reason for the communications gap is that many pilots and controllers don't understand the circumstances under which the other is operating.

To help solve the problem, AOPA has launched a "Fly-A-Controller" program. It has the blessing of the Federal Aviation Administration (FAA) and the support of the Air Traffic Control Association.

Under the voluntary program, in which Lang was one of the first participants, pilots offer flights in general-aviation aircraft to controllers. The controllers can thus see firsthand the differences between small aircraft and larger commercial aircraft to which the air-traffic control system is geared. "You get a set viewpoint when

you're working in the tower," says Lang, who works at Centennial Airport in Denver.

On his roundtrip flight between Denver and Aspen, provided by Bernard Conway in a Lear 55, Lang says he got "a different view" of what the air-traffic control system is all about. With headphones on, he was taking orders from control towers and finding to his surprise that the attention of the general-aviation pilot is focused on several jobs simultaneously, such as keeping the aircraft stable in flight and responding to directions from controllers. "I wasn't aware they had as much to do," he says, "and their margin for error is much smaller than that for larger aircraft."

Says Conway, a pilot for 26 years: "They see the other half of what they are doing, and perhaps come to realize that they are controlling aircraft that are more than blips on the radar screen. It's a chance to appreciate the other person's job."

Conway and Lang are already touting the benefits of the program to others. Echoing Conway, Lang says, "We can realize pilots have needs that maybe we aren't meeting, and they can realize that a lot of things we do in the control tower are for safety reasons and aren't personal."

Hundreds of controllers have now flown in light aircraft, according to AOPA, a Maryland-based trade group of more than 265,000 pilots. And the wide range of general-aviation aircraft has made for some unusual offers. For example, Robert L. Henn, Skywatch pilot at WING radio in Dayton, Ohio, gives rides to controllers at the city's airport during the station's traffic-report flights. And two controllers in Austin, Texas, recently spent an hour aloft in a balloon piloted by an AOPA member.

However, AOPA was not the first group to address the communications problem. The FAA started "Operation Raincheck" in the early 1970s to show pilots the controller's environment. "The program was designed to bring pilots into air-traffic control facilities," says Dick Stafford, an FAA spokesman. "And it's still operating. Pilots are always welcome at any facility."

In AOPA's "Fly-A-Controller" brochure, pilots are advised on how to conduct the flight, including allowing the controller to operate the radios. Pilots are also cautioned to discontinue the flight "if the controller becomes ill or uncomfortable." Esther Kontas, a radar trainee at Washington-Dulles Airport, recently took her first flight in a light aircraft, a four-place Cessna Skylane. "I enjoyed it," she says. "There's sure a lot of stuff for one pilot to do, though. I guess I did okay on the radios, but I did start getting a little seasick."

—Reginald Stuart



Celestial Lost-and-Found

Whether you've lost your bearings or a truckload of ball bearings, help is on the way from the Geostar Corporation. Gerard O'Neill, founder and chairman of the company, is working to establish a positioning and communications service using satellites and small transmitter-receivers powered by ordinary penlight batteries.

That may sound like a concept straight from "Amazing Stories," but the recent launch of Geostar's first radio relay device makes it more than conceptual. The relay, which receives transmissions and sends them to Geostar's headquarters in Princeton, New Jersey, hitchhiked aloft attached to a GTE satellite launched by a European Ariane rocket in March. "We're obviously very pleased that all went according to plan," says Blaine Vincent, the company's sales director. "We look forward to this being the first step in our business."

A former Princeton University physics professor and an amateur pilot, O'Neill started thinking about using satellites as the basis of a collision-avoidance system after reading about two airplanes colliding over San Diego in 1978. By 1982 he had obtained patents for his concept, and formed Geostar the next year. Moving right along, the company conducted feasibility tests in Nevada, using mountain peaks as surrogate satellites to guide a van to a spe-

cific address, among other positioning tasks. Things were looking up.

Last year the fledgling company received radio frequency allocations from the Federal Communications Commission. And by the time of the Ariane launch, O'Neill was no longer a lone entrepreneur—among the heavy hitters signing on were Morgan Guaranty Trust, Sony, RCA, and Comsat.

When fully operational, here's how the Geostar system will work: say a user—perhaps a lost trucker en route to Texas with a load of lobster—wants to know his position. He simply types his request into his transceiver, which beams a signal to two satellites. Both satellites send signals to Geostar's computer in Princeton, which compares the two transmissions and triangulates the confused trucker's location to within several yards. The computer then sends this fix back to the trucker's transceiver via satellite. The whole process should take less than a second.

Should the trucker send a message, it will be relayed by Geostar to his company. If the Texas-bound lobsters have somehow ended up in Wisconsin, the trucker's bosses will know. They can then signal the driver that he is fired.

But two-way communications will have to wait until at least 1988, when Geostar adds more space-based relay devices. Numbers two and three were scheduled to ride on satellites to be orbited by shuttle, which

may delay plans further. By piggybacking them on satellites, the cost to launch the relays is only \$13 million, compared with a satellite's customary \$100 million price tag.

However, Geostar will begin a limited one-way service, called Link 1, in September. The first customers are trucking and rail companies that want to get a quick fix on their trucks and trains. A truck, for example, will be able to send a signal via satellite, but won't be able to receive a reply. Instead, Geostar will relay the position and message to the trucker's home office, and earthbound dispatchers must take over from there.

The Leaseaway Transportation Corporation of Cleveland, Ohio, has already ordered 100 transceivers. "Link 1 will provide us with the ability to know the location of any shipment," says Peter Smith, the company's senior vice president. "We can offer a higher standard of service than when we have to rely on the truck driver to get out of his cab and find a telephone."

"Customer response has been very gratifying," says Vincent, who reports nearly 15,000 advance orders. The transceivers, about the size of a CB radio, cost \$2,900 apiece, and customers will buy them directly from the manufacturers. Geostar makes its money by charging a monthly fee of \$45, good for 270 transmissions.

O'Neill wasn't the first to think of using satellites for navigational purposes. The Department of Defense already has a satellite-positioning system called Navstar (Navigation System Time And Range) in limited operation. Navstar will eventually employ 18 satellites to give positions accurate to within 50 feet. The Pentagon had initially hoped to recoup some of its multi-billion-dollar cost by allowing civilians to use the system for a fee, but decided to offer the service gratis after the Soviet Union downed a wayward Korean Airlines jet in 1983. Receivers for the system, however, will cost \$15,000 to \$150,000.

Geostar's big advantage is its potential for two-way communications, which Navstar lacks. And if O'Neill realizes his ambition of supplying transceivers that are as small as pocket calculators and cost less than \$100, usage could expand to include hikers, skiers, and other individual users worldwide.

Does this scheme carry a hint of a Big Brother in the sky? "That's something we're very concerned about," says a Geostar spokesperson. "Your location will never be revealed to anyone unless you key in a specific request." Geostar may also encrypt messages to prevent interception by any eavesdropper with a satellite dish.

—Richard Corrigan

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The Crowded Sky

Every month, I receive a document from the National Aeronautics and Space Administration's Aviation Safety Reporting System. It's just a single sheet, entitled *Callback*, and it describes itself as "an informal monthly bulletin"—which it is.

But it's also charming, funny, disturbing, revealing, and surprisingly readable. It reprints the reports of pilots, often embarrassed ones, who have gotten themselves into heaps of trouble, usually because of their own dumb mistakes. A recent edition contained this item:

"Alone in a light twin. Just after liftoff, applied brakes prior to retracting gear. PLOP! Something lands on my left sleeve. . . . a spider (size, including legs, about the same as a 50-cent piece), and we glare at each other. I am not at all fond of spiders. If given the choice at all—*any* choice—I will not knowingly share the same space with a spider." The pilot went on to say that he'd gotten out of this pickle all right, and he even drew the appropriate moral about checking for unauthorized passengers before takeoff.

His story led me to reminisce about similar events that occurred in single-seat airplanes during World War II in New Guinea, where I flew a Bell P-39 Airacobra fighter. In this airplane, the space designed to accommodate the pilot hardly qualified as a seat at all. The pilot could barely cram himself and his gear into it without some method. Here's how it was done:

Over your khaki shorts (uniform pants sawed off with a hunting knife) you wore a flight suit, shoulder holster, and belt with canteen. You strapped your knife to the outside of your right shin. You climbed up onto the wing of your airplane and put on the Mae West life preserver that the crew chief had hung on the door. After easing your left leg past the control stick, you worked your buttocks onto your parachute, which was always left on the seat. The crew chief had to help you tuck your right leg in, then snap the parachute straps around you. You brought the shoulder harness down across your torso and clicked it into the quick-release catch of your safety belt. Trussed in this webbing, you then plugged in the dan-



Randy Lyhus

gling oxygen tube and radio leads.

This done, you were now ensnared, virtually immobile, straps and equipment bulging into every cranny of the cockpit, head barely clearing the canopy above you. "*Pull the switch, warden,*" you would think to yourself at this point.

Folded on top of your parachute, which you were now perched upon, was a one-man inflatable rubber raft, its compressed-air cartridge to be activated by a little yellow cord that dangled between your legs. Over the raft lay a sponge-rubber mat, designed to add luxurious comfort to your mission. This thing always got very thin and very hard after half an hour's flying. But by the end of two and a half hours it didn't matter, because that part of your body was numb.

Obviously there was no room for anything in this cockpit but the wretched pilot. Nonetheless, one of my colleagues man-

aged to get himself entangled in that little yellow cord and inflate the life raft while flying at 12,000 feet. He survived the event, and we were all eager for details. This is what he told us:

He'd loosened his harness a bit for the sake of comfort, when suddenly, this bulging yellow monster came to life all around him, snapping and hissing and popping as it bloomed. It wrenched him from the controls, causing the airplane to gyrate madly out of formation, to the astonishment of the other pilots in his flight. "Jello Blue Two," they called in trembling, tentative voices. "Is something wrong?" He was far too preoccupied to answer, and all they could see in his cockpit was a writhing mass of yellow.

The pilot finally managed to extract his sheath knife and stab the beast to death. Then, sheepishly, he rejoined his formation.

Occasionally, an unwelcome companion would cause enough excitement to be grounds for an abort. One problem in the tropics was that snakes apparently craved the feel of parachute silk and would squeeze into the packs at night. In my squadron, the parachute sergeant had the miserable duty of spilling and repacking the chutes almost every day. And not infrequently, we would see one or two dead snakes hanging outside the parachute tent. Which leads us to the case of the fighter pilot on patrol out of Darwin, in northern Australia.

He was climbing to altitude with his flight of P-40s when he noticed a movement in the cockpit and discovered a three-foot death adder winding its way up the stick toward his right hand. Very carefully, so goes the story, he slid open the canopy, rolled the airplane on its back, and gently rocked it up and down. Sure enough, the creature lost its grip and tumbled out, in a split second passing the man's face close enough for him to see the adder's bared fangs.

I don't know what happened to that pilot, but he could be forgiven if he didn't complete that particular mission. The aforementioned *Callback*, in fact, may provide some insight into how he felt. One of its reports, reprinted in its entirety, says, "I am not going to fly anymore!"

—Edwards Park

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1232669. FRENCH	1232768. PERSIAN	1232842. TURKISH
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Anniversaries and Events

1909

June 16 The aircraft industry is born at Hammondsport, New York, with the first commercial sale of an aircraft: The Aeronautical Society of New York purchases the *Golden Flier* from Glenn Curtiss for \$5,000, to be paid in installments. Such an arrangement leads Curtiss to caution his first student, "For God's sake, don't break it, it is not all paid for."

July 25 Frenchman Louis Blériot is the first to cross the English Channel via air-

plane. The Blériot XI monoplane makes the flight from Calais to Dover in 36½ minutes to win the *Daily Mail* prize of £1,000.

1911

July 1 The U.S. Navy takes delivery of its first airplane, a Curtiss A-1 Triad, at Hammondsport, New York (see Events).

1912

June 11 Silas Christoferson is the first to depart from the roof of a hotel in an airplane (and probably in a snit, too).

Christoferson left the Multnomah Hotel, Portland, Oregon, in a Curtiss biplane.

1919

June 14-15 John Alcock and Arthur Brown make the first nonstop crossing of the Atlantic Ocean, from Newfoundland to Ireland, in 16 hours 27 minutes in a Vickers Vimy bomber.

July 2 The first aeronautical stowaway departs Scotland aboard the British R-34, the first airship to cross the Atlantic. William Ballantyne, a rigger, was to be part of the crew for the flight but was laid off to lighten the load. Ballantyne and the R-34 arrive in New York on July 6.

1927

June 5 The Society for Space Travel (Verein für Raumshiffahrt, or VfR) is founded in Breslau, Germany. Among its originators is the 15-year-old Wernher von Braun. When the VfR attempted to register as an official organization, government authorities balked at "Raumshiffahrt," a combination of the German terms for "spaceship" and "travel," claiming that neither the word—nor the concept—existed.

1929

July 15 The Oakland Airport Inn, the first airport hotel, opens in Oakland, California. (It's been downhill ever since—just ask Mr. Christoferson.)

1933

July 15 Wiley Post departs on the first world solo flight in the Lockheed Vega *Winnie Mae* via New York—Berlin—Moscow—Alaska—New York. Post covers the 15,596 miles in just over a week.

1962

July 10 The launch of the private communications satellite Telstar 1 allows for a transatlantic exchange of TV programs. This is considered to be the first development of the space race to benefit the layman (if you don't count Teflon and Velcro, both of which became available to the public in 1958).



"Look—up in the sky! It's a flock of birds. It's a cloud. It's the Montgolfier Brothers."

1963

June 16 Cosmonaut Valentina Tereshkova is the first woman in space, aboard the Soviet Union's *Vostok 6* spacecraft.

1969

July 20 Neil Armstrong is the first human being to alight on the moon, via the Lunar Module *Eagle* and Apollo 11.

1976

July 20 The Viking Lander 1, the first spacecraft to conduct extended studies on another planet, lands on Mars. Transmissions of data and photographs continue for almost six and one-half years.

1979

June 12 Paul MacCready's *Gossamer Albatross*, pedaled/piloted by Bryan Allen, wins the £100,000 Kremer prize for the first human-powered aircraft to cross the English Channel. Allen makes the 22½-mile flight in just under three hours (see page 48 for a related story).

July 11 The Skylab Orbital Workshop breaks up into pieces and falls onto the Australian Desert and into the Indian Ocean af-

AP/Wide World Photos



To new heights in a lowly lawn chair.

ter orbiting the Earth once every 90 minutes for six years.

1982

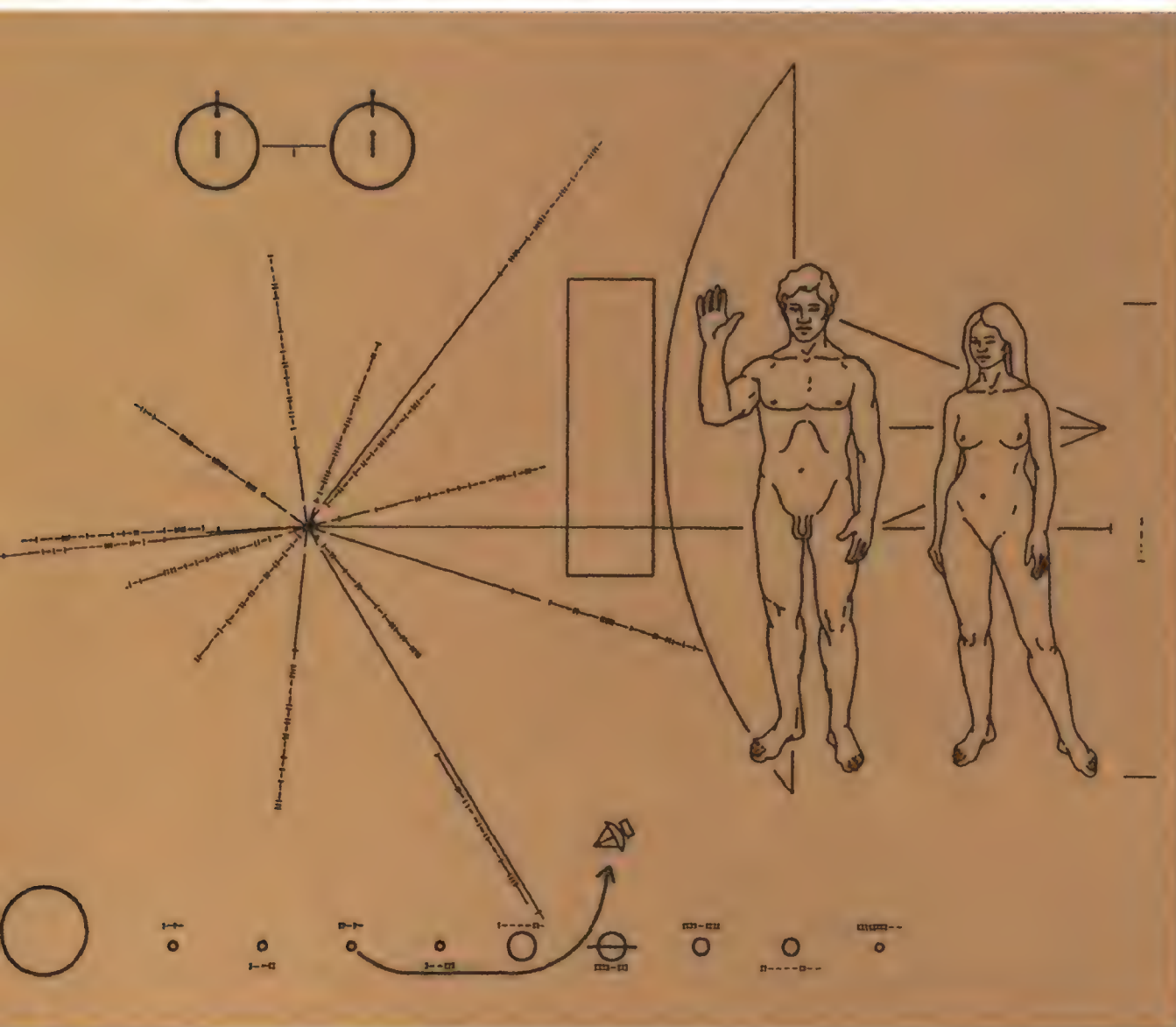
July 2 Larry Walters, a 33-year-old truck driver, departs from his girlfriend's back yard in San Pedro, California, in a lawn chair powered by 45 helium balloons. After a leisurely 90-minute ascent to 16,000 feet, where he startles first a TWA and then a Delta pilot, Walters shoots out 10 balloons with a BB gun and eventually lands in power lines, blacking out a small section of Long Beach. The Federal Aviation Administration charged him with operating his lawn chair "without an airworthiness certificate," among other violations. "I wouldn't do it again for anything," Walters says later, "but I'd be happy to endorse Sears lawn chairs."

1983

June 13 Pioneer 10 becomes man's first messenger to interstellar space when it exits the known solar system. The spacecraft carries a plaque designed to inform any intelligent life about the craft and where it came from.

June 18 Sally Ride is the first American woman to travel into space, aboard the space shuttle *Challenger*.

An interstellar message via Pioneer 10: RSVP.



NASA/NASM

Many anniversary dates were drawn from Milestones of Flight, Michael J.H. Taylor and David Mondey, Jane's, 1983.

Events

Through June 22

"America's Space Truck: The Space Shuttle" (Smithsonian Traveling Exhibition). Des Moines, Iowa, at Des Moines Center of Science (515)274-4138 and New London, Connecticut, at Thames Science Center (203)442-0391.

Through July 6

"Jupiter and Its Moons" (Smithsonian Traveling Exhibition). Miami, Florida. At Miami Space Transit Planetarium (305)854-4242.

Through July 27

"Images of the Universe: The Artist's Vision." Ames, Iowa. A multimedia show of 78 pieces. At Brunner Gallery and Museum (515)294-3342.

June 6-15

Hannover Aerospace Exhibition. Hannover, West Germany. Hannover Fairs USA (609)987-1202.

June 7

DC-3 Armada Day. Vancouver, British Columbia. Presented in association with "Expo '86" (604)660-3976.

June 7-July 13

"Early Flight: 1900-1911" (Smithsonian Traveling Exhibition). Janesville, Wisconsin. At Rock County Historical Society (608)756-4509.

June 8

59th Annual Parks College Open House and Airshow. Cahokia, Illinois. Aerobatics, antique and experimental aircraft display, 11 am-5 pm. (618)337-7500.

June 11-15

"Texas Air Expo: A Sesquicentennial Event." Waco, Texas. Goodyear blimp, Silver Bullet jet, Eagles aerobatic team, the Concorde, Confederate Air Force, USAF Thunderbirds. At Texas State Technical Institute Airport (817)753-1505.

June 13-July 13

"Black Wings: The American Black in

USAF

Aviation" (Smithsonian Traveling Exhibition). Los Angeles, California. At California Museum of Afro-American History and Culture (213)744-7432.

June 14-15

East Coast Aerobatic Championships. Winchester, Virginia. At Winchester Municipal Airport. International Aerobatic Club (703)439-8127.

June 14-15

"Festival of Flight." College Park, Maryland. A celebration of aviation at the world's oldest continuously-operating airport. Aircraft, helicopter, and hot-air balloon rides, "Flying Circus" airshow, National Guard fly-by. Transportation to tours at Goddard Space Flight Center in Greenbelt. Refreshments, music. 10 am-sunset Saturday, 12-6 pm Sunday. At College Park airport

(301)927-1909.

June 14-August 31

"Twenty-five Years of Manned Space Exploration" (Smithsonian Traveling Exhibition). Tampa, Florida. At Museum of Science and Industry (813)985-5531.

June 21-22

"Aeroheritage '86" Airshow. Mt. Hope, Ontario. An international representation of World War II aircraft. At Hamilton Civic Airport (416)679-4141.

June 21-22

"Aerospace America '86." Oklahoma City, Oklahoma. Aerobatic performances, skydiving, military demonstrations, static exhibits, and more. At Will Rogers World Airport (405)681-2361.

June 22-26

168th Annual American Astronomical Society Meeting. Ames, Iowa. More than 500 astronomers, publishers, and corporate sponsors will discuss the past year's astronomical developments. Registration required. At Iowa State University. AAS (202)328-2010.

June 28-July 1

"Festival of Flight." Hammondsport, New York. Unveiling of a monument to Glenn Curtiss to commemorate the delivery of the Navy's first aircraft in 1911. Flight of an A-1 Triad replica, current military fly-by, seaplane fly-in. Curtiss Museum of Local History (607)569-2160.

July 3-6

"Liberty Weekend '86." New York Harbor and New York City. Up to 13,000,000 people are expected at the Statue of Liberty Centennial. If you don't have tickets by now, you can join in the festivities from your couch via ABC-TV. Blue Angels, Thunderbirds, 100 Tall Ships, 40,000 boats, 35 international naval vessels, historic aircraft fly-by, parades, concerts, the world's largest fireworks display.

July 6-16 (also July 20-30)

International Aerospace Camp. Grand Forks, North Dakota. Aviation/aerospace history and future, meteorology, astronomy, field trips to an air force base, a flight service station, and an airline's headquarters. Flights in a hot air balloon, a Hughes 300 helicopter, a Cessna 152, and a Super Decathlon aerobatic airplane. At University of North Dakota (701)777-2663.

July 8-12

Hitachi International Masters of Soaring Invitational. Minden, Nevada. All pilots in this prestigious soaring contest are champions of a national or world event. Soaring Society of America (505)392-1177.

July 12-August 10

"America's Space Truck: The Space Shuttle" (Smithsonian Traveling Exhibition). Fort Lauderdale, Florida, Discovery Center



Air Force Thunderbirds—mission: summer airshows.

(305)462-4115 and Pensacola, Florida, Cordova Mall (904)477-5462.

July 13-19

"A Sentimental Journey to Cub Haven."

Lock Haven, Pennsylvania. More than 14,000 ragwing (cloth-covered) Piper owners have been invited to this nostalgic convention. Seminars, workshops, aviation flea market. Camping available. At Piper Memorial Airport (717)893-4200.

July 14-16

Aviation History Seminar. San Diego, California. Lectures and films on the Golden Age of Flight, 75 years of naval aviation, and aerodynamics today. Led by curators from the National Air and Space Museum. At San Diego Aerospace Museum. Call Smithsonian National Associates for ticket information (202)357-1350.

July 16

Mars makes its closest approach to Earth in 15 years—37,429,400 miles.*

July 21-23

Mars Conference. Washington, D.C. Panel discussions on the future manned and unmanned exploration of Mars. Discussions to be led by Dr. Geoffrey A. Briggs, director of the Solar System Exploration Division,

NASA. At National Academy of Science. (804)865-8400.

July 24-27

Dayton International Airshow and Trade Exposition. Dayton, Ohio. Thunderbirds, Golden Knights. At Dayton International Airport (513)898-5901.

July 26

National Enshrinement. Dayton, Ohio. Five aviation figures will be named to the National Aviation Hall of Fame at its 25th anniversary. Ceremonies and dinner at Dayton Convention and Exhibition Center (513)226-0800.

July 29

South Delta Aquarids meteor shower. Two to three hours before sunrise.*

August 1-8

Experimental Aircraft Association Annual Convention and Sport Aviation Exhibition. Oshkosh, Wisconsin. For one week, the EAA airport is the busiest in the world as thousands of classic, homebuilt, and general aviation aircraft and pilots descend on the Mecca of sport flying. At Wittman Field (414)426-4800.

August 4-10

"Air Fair '86." Vancouver, British Colum-

bia. Aviation week at "Expo '86."

Flight Into History program, parachuting championships, aviation exhibits including a walk-through Soviet space laboratory. (604)660-3976.

August 8-10

Abbotsford International Aviation Exhibition and Airshow. Abbotsford, British Columbia. Blue Angels, Canadian Snowbirds, Golden Knights, Concorde—with the peaks of the Cascades Mountains for a backdrop. At Abbotsford Airport (604)859-9211.

August 8-15

34th Annual Antique Airplane Association Fly-in. Blakesburg, Iowa. The world's oldest antique/classic aircraft fly-in. At Antique Airfield (515)938-2773.

*Call the Smithsonian "Earth and Space Report" for recorded information on astronomical events at (202)357-2000.

Organizations wishing to have an event published in "Calendar" should submit them at least three months in advance to Calendar, Air & Space Magazine, Room 3401, National Air and Space Museum, Washington, DC 20560. Events will be listed as space allows. —Patricia Trenner

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The Museum's Birthday Presence

Ten years ago, on a warm, sunny July 1 in the Bicentennial year, a signal originating on the Mall in Washington traveled 220,000,000 miles to the Viking Lander 1 orbiting Mars. The spacecraft obligingly translated the signal and returned it to Earth, to a duplicate model of Viking's Soil Sampler, which then snipped a narrow red-white-and-blue ribbon, officially opening the new National Air and Space Museum.

It was an appropriately grand gesture to herald the latest addition to the Smithsonian. It was also appropriate, given the new museum's thoroughness, that the chief of the audio-visual department stood by to "assist" the Sampler arm if the Viking message didn't come through.

During the ceremony on the steps overlooking the Mall, President Gerald Ford presented the Museum to the country, calling it "a perfect birthday gift from the American people to themselves." The Air Force Thunderbirds roared overhead in salute, with the blessings of the Secret Service, which allowed a "just-this-once" exception to the rule that prohibits flights over the Mall and the White House.

The engineering of the building and its galleries was also exceptional: the project was completed in just over three and a half years—four days ahead of schedule, in fact—and half a million dollars under its \$41.9 million budget.

The Smithsonian began its aeronautical collection with a gift of Chinese kites 100 years before the new building opened. In the 1920s, aircraft were crammed into a tin shed on the Mall, and some eventually spilled over into the Arts and Industries Building next door, where they were hung rather unceremoniously in whatever space could be begged or borrowed. The tin shed was officially designated the National Air Museum in 1946, but lacking space, aircraft were in storage all over the country, and later, at the Museum's Silver Hill facility in Maryland. It was not until 1972 that Congress finally appropriated funds to build a full-blown museum, the title of which had been expanded to National Air and Space Museum in 1966.

Architect Gyo Obata designed a building

Barbara Martin



Tennessee marble and tinted glass house aviation's history.

hailed by critics as an ideal blend of innovation, practicality, and cool elegance. A staff of 200 took on the challenge of creating 23 galleries and filling them with airplanes, spacecraft, mannequins, placards, murals, films, a planetarium, an IMAX theater, and most importantly, people: estimates ranged between 1,500,000 and 7,000,000 visitors per year. An hour after the doors opened to the public, 8,000 had toured the three-block-long building; by the end of the first year, almost 10 million people had visited their Bicentennial birthday gift. All appreciated the magnificent marble and glass hangar, but few could fathom the tremendous effort behind its existence.

Some Museum staffers recall the final frenzied year when the exhibits began to take shape. "It's probably like having a baby," says Claudia Oakes, associate curator, aeronautics. "After you've had it, you tend to forget how uncomfortable you were." But prospective mothers don't need hard hats. Museum employees did.

Don Lopez, deputy director, remembers the flair with which Eric Sloane, then 66, painted the six-story mural depicting the Earth's atmosphere from the Grand Canyon to the aurora borealis. "The sun through the windows made it very warm in here, even in January," says Lopez. "Mr. Sloane used to paint in—well, in his underwear. He used a house-painting brush and a garbage can lid for a palette, and he finished the entire 75-foot-wide mural in about two months."

A project involving hundreds of priceless artifacts and tons of heavy equipment is statistically fraught with potential mishaps, and the Museum suffered its share. Director Walter Boyne, then curator of aeronautics and chief of Silver Hill, oversaw five teams charged with moving 200 aircraft and spacecraft into the building. The docile Douglas DC-3 developed a mean streak: as contractors hoisted the 8-1/2-ton transport to the trusswork, a clamp slipped and one of the DC-3's wing tips slammed down to the floor 18 feet below—probably no harder than it might have hit in a botched landing. Nonetheless, Boyne says, "In a terrifying situation, most people see their past flash before them. Not me. I saw my future disappear in an instant." A spare wing tip was located and installed immediately.

In another incident shortly before the opening, Ed Chalkley, then a museum specialist, was assured by a contractor that the raised wooden floorboard in the World War I gallery could support a forklift and more. It didn't. Lopez, then assistant director of aeronautics, donned overalls and was on hands and knees frantically driving nails

when a group of VIPs arrived for a pre-opening tour.

After the dust had settled, director Michael Collins and his fellow employees spent the last few days polishing brass and washing windows. The effort paid off. "We knew it was going to be popular," Collins says, "but it exceeded even our high expectations."

"The staff, volunteers, contractors, army personnel, union and non-union people all worked together in perfect harmony," says Boyne. The riggers, in particular, approached the project with near-reverence. "One of the rigging chiefs argued with me endlessly over the aesthetics of banking the North American X-15 a few more inches," Boyne adds. "They were really caught up in the experience."

In the past ten years, approximately 100 million people have shared in the results of that experience. And what does the next decade hold? With new acquisitions now spilling into nearby Washington-Dulles airport, a new Dulles wing—"the Museum of the Twenty-first Century," Boyne calls it—is the next step, if Congress approves.

Meanwhile, the museum on the Mall continues to impress its visitors, sometimes unintentionally. One afternoon, when a forklift ran out of fuel between two Mercury spacecraft in an exhibit area, its operator carefully roped it off and left in search of propane. A couple walked up to the exhibit, and the woman, pointing at the forklift, asked her companion, "Did that really go to the Moon?" "Of course, dear," he replied condescendingly. "If it didn't, it wouldn't be here."

Dr. MacCready's Time Machine

Two hundred million years ago, in the Age of Reptiles, huge winged lizards soared over the shallow Kansas Sea in what was to become the midwestern United States. The pterosaurs, the largest animals ever to fly, ranged hundreds of miles from the sea's border, snapping up huge prehistoric dragonflies in flight and swooping low over rivers in search of prey. Graceful and menacing aloft, they were as clumsy as an albatross on land. The pterosaurs thrived for 150 million years, but whatever ended the reign of the dinosaurs also brought down their airborne cousins.

Today, in the age of the computer, the pterosaur flies again, thanks to Paul MacCready, best known as the father of human-powered aviation.

Quetzalcoatlus northropi, or QN, named after the Aztec feathered serpent god and John K. Northrop, builder of the flying wing aircraft that entered service briefly in the

late 1940s, has its roots in a discovery made in Big Bend National Park in western Texas. There, in 1972, paleobiologists unearthed pterosaur bones indicating a 36-foot wingspan, eclipsing previous finds half that size.

MacCready, having conquered the English Channel with human- and solar-powered aircraft in 1979 and 1981, was ready for another record-breaking project, and with the backing of his engineering company, the Museum, and Johnson Wax, set out to build an 18-foot replica that would star in a film about the relationship between natural and mechanical flight.

In July 1984, MacCready held a two-day workshop at the California Institute of Technology—which drew NASA engineers, aerodynamicists, paleobiologists, ornithologists, and a former designer from the company that makes Frisbees—to brainstorm the feasibility of the project. From this diverse group came the hypotheses of QN's past and future, and MacCready and a crew of 20 began working with progressively larger bird-like gliders.

"We went through the evolutionary process, just as in nature," says MacCready. "But we had to evolve at the rate of a million years a week." During QN's evolution, locals were bemused by the sight of a van cruising the streets of Simi Valley, California, with a pterosaur flapping about on the roof, learning the art of flight.

Building a large but fragile wing-flapping machine was fraught with numerous difficulties. A popular theory says bumblebees can't fly; neither should a pterosaur: its long neck and beak and lack of a tail spelled aerodynamic instability to aircraft designers. "It's like trying to shoot an arrow with the tail feathers in front," explains Alec Brooks, QN project manager. QN would have to fly by "active control," a continuous readjusting of balance, similar to the process we use to stay upright while riding a bicycle. Finally, the replica had to be extremely lightweight, yet sturdy enough to carry the hardware for its "brain" and "muscle" systems.

Through innovative design compromises, MacCready and his team combined characteristics of prehistoric fliers with space-age materials, echoing the theme of *On the Wing*, the film in which the replica stars. "We built an actor that became a metaphor and a logo for the entire movie," says MacCready. (See "Previews," page 114.)

From the Mesozoic Era came the design concept of using a set of claws on the leading edge of each wing as lift spoilers, which aid in turning by raising one wing while lowering the other. The directional instability problem was solved by using the long neck



The Big Bird: a giant step backward.

and beak as a rudder that swivels left and right on a ball-and-socket joint.

From birds came the ability to sweep the wings forward and backward, controlling climb and descent, as well as flapping up and down, propelling it through the air. A bird can also twist its wings along the horizontal axis to assist in turning. (This wing-warping concept was first applied to aircraft by the Wrights in 1900.)

From current technology came the mechanics and electronics that comprise QN's nervous system. An onboard computer and autopilot are the components of a sophisticated birdbrain. Small but powerful motors running on nickel-cadmium batteries activate drives that govern the sweep and flap of the wings. Commands to turn, descend, or to vary the flap rate are radioed from a pterosaur pilot on the ground to the computer, which also receives data from a wind-flow vane monitoring forward velocity and a gyroscope monitoring rate of turn and attitude.

This remarkable combination of past and present is contained in a structure of carbon-fiber composite bones, a Kevlar skeleton, and latex wing skin covered with artificial fur. The replica weighs 44 pounds, a fraction of the 140 pounds estimated for the original.

Outwardly, QN appears more faithful to nature's design. The fur-covered body, leathery wings, bright red beak, blue-green crest, and bright, glassy eyes make for an awesome sight in flight but one less threatening up close. "It's so ugly, you have to love it," says MacCready.

After several false starts, including one in which QN flew into power lines and blacked out Moorpark, California, the \$700,000 replica flew successfully at El Mirage Dry Lake Bed in the Mojave Desert on January 7. Museum director Walter Boyne proudly announced, "It flew like a properly behaved pterosaur ought to." After the filming for *On the Wing* was completed, plans called for QN to fly up and down the Mall, the large park outside the Museum. But because the pterosaur must be launched on a 2,000-foot towline, the

Mall was ruled out as too confining, and the first public flight has been moved to Andrews Air Force Base in Maryland. After one or two five-minute flights on May 17, QN will go on display in the Museum.

Among the fan mail MacCready received is a letter from a four-year-old who hopes that "baby pterosaurs are friendly and not afraid of children." MacCready, 60, delighted by such inquiries, would next like to create QN II, twice the size of his current offspring, and envisions an outdoor prehistoric museum filled with "giant flying dinosaurs and land dinosaurs the size of bulldozers" as an educational appetizer for children, whom he sees as "the best form of life on this earth."

When Reach Exceeds Grasp

The Smithsonian sponsors a series of traveling exhibits, and some of the Museum's property has roved as far as Australia, Jakarta, and Singapore. But nothing to date can outdistance the Museum's most remote asset: the Viking 1 Lander. Ten years ago, it landed near Chryse Planitia, on Mars. The National Aeronautics and Space Administration turned it over to the Museum in May 1984. So far, Mars hasn't sent it back, so an engineering model is on exhibit here.

Museum Calendar

Except where noted, no tickets or reservations are required. Call Smithsonian Information at (202) 357-2700 for details.

Summer Concert Series. Music by U.S. armed services bands, selected weekdays on the west terrace, 12-1 pm.

June 7 Monthly Sky Lecture, 9:30 am. "Astronomical Treasures of Great Britain," Albert Einstein Planetarium. Thomas H. Callen II, Program Resources Manager; Planetarium.

June 9 "New Discoveries of Uranus" slide lecture, 8 pm. Joseph Boyce, Chief of Planetary Geosciences Programs, NASA. Call Resident Associates Program at (202)357-3030 for ticket information.

June 17 "The Golden Age of U.S. Naval Aviation" lecture, 10:40 am. E.T. Wooldridge, Chairman, Department of Aeronautics, Air and Space Museum. Call Resident Associates Program at (202)357-3030 for ticket information.

June 20 *On the Wing* premiere, Langley Theater. Continual showings daily. This dramatic new IMAX film, starring the flying pterosaur model "Quetzalcoatlus northropi," or QN, explores the relationship between natural and mechanical flight.

Tickets required. QN will be on display in the Museum.

June 21, 23, 24 *On the Wing* IMAX film, 7:30 and 9 pm. Langley Theater. Introduced by principal members of the team that created QN. Call Resident Associates Program at (202)357-3030 for ticket information.

June 25 Exploring Space Lecture, 7:30 pm. "Looking Out from the Outside: The Hubble Space Telescope." Albert Einstein Planetarium. Dr. C. Robert O'Dell, professor of space physics and astronomy, Rice University.

June 25 "International Encounters with Halley's Comet" lecture, 8 pm. John C. Brandt, astronomer at Goddard Space Center. Call Resident Associates Program at (202)357-3030 for ticket information.

June 27-29 Air and Space Associates three-day weekend tour with curators. *On the Wing* and *The Dream Is Alive* IMAX films, Museum tour, Garber Facility tour, lunches, dinners, and lectures with Museum staff members. Accommodations and meals included. Call Associates Travel Program at (202)287-3362.

July 1 Tenth anniversary of the Museum. Day-long birthday party 10 am - 7:30 pm, concerts, telescope viewing, unique photo opportunities.

July 4 Air Force Bands "Spectrum" and "Airmen of Note" in concert, 3-7 pm, Museum steps facing the Mall.

July 5 Monthly Sky Lecture, 9:30 am. "The Past Decade in Space," Albert Einstein Planetarium. Geoffrey Chester, Production Coordinator, Planetarium.

July 5-6 Ultralight Aircraft Fair, east terrace of the Museum. Eight recreational aircraft will be on display, and their owners will be present to answer questions. Presented in association with the Experimental Aircraft Association.

July 9 "Air Traffic Control" exhibit opens, Gallery 102. This new exhibit commemorates the 50th anniversary of the establishment of the air traffic control system in the United States.

July 23 "Viking on Mars: Ten Years Later," 1:30-5 pm. Albert Einstein Planetarium. Lectures on the results of the Viking Mission to Mars, and plans for future missions.

Come visit your Museum on a "Washington Anytime" weekend—two nights (double occupancy) for \$99. Includes accommodations, some meals, Museum tour, Smithsonian Castle tour, IMAX film. For details, call or write: Associates Travel Program, Capital Gallery 455, Smithsonian Institution, Washington, DC 20560. (202)287-3362.

—Patricia Trenner

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Ariane



Quatre, trois, deux, un . . .

By Alfred Meyer

Supporting a crimson hibiscus blossom in her dark hair, the French chanteuse steamed through her repertoire, accompanying herself on the piano and puffing a Gitane between verses. The restaurant where she played was La Belle Époque, "the good old times," and the nostalgic music suited the name, tunes like "Begin the Beguine" and "Milord." Judging from the conversation of the clientele as well as the Bordeaux wine adorning the tables, it might have been Paris.

The sudden showers that intermittently drenched the lush tropical garden outside, however, indicated otherwise. This was instead Cayenne, famous for its hot peppers and prisons—the capital of French Guiana, since 1946 an overseas department, or state, of France. And if the contrast between European and native culture in this sprawling city on the northeastern coast of South America was evident in language, cuisine, and pace, it was even more pronounced 50 miles north at Kourou.

Formerly a small fishing village, Kourou is now marked by row after row of development bungalows, a shopping mall, and a strip of sandy beach where tanned sun worshipers take their ease. And behind this French suburban facade, scientists, engineers, and technicians are deeply engaged in the complex business of sending satellites aloft. For Kourou is the site of the European Space Agency's 1,000-square-kilometer space flight center. Rising improbably

A sergeant of the Foreign Legion's Third Regiment represents the long arm of Paris in French Guiana (left).

The Ariane adds steam to the jungle at Kourou, for now the most active satellite-launching facility (right).

Photographs by Lee Battaglia

CNES



out of the jungle like an array of well-aimed sun temples, the center also finds itself suddenly thrust into the international limelight.

With the National Aeronautics and Space Administration's shuttle program temporarily on hold, Arianespace—the company that conducts launches at the Kourou space center, builds the Ariane rockets, and oversees the rockets' commercial use—is for now the only venture anywhere actively putting commercial satellites into orbit. Arianespace is a consortium of European banks and aerospace companies, with France's national space agency playing a lion's role.

Aside from its geographic remoteness, its ultramodern launch facilities are part of what make the center at Kourou unique. In addition to such standard features as full-bore meteorological and radio-telemetry stations, there is a satellite inspection hangar so cavernous that when its interior lights flick on in sequence it seems like the arrival of day; a medically familiar radiographic room in which rocket motors get X-rayed; a twenty-story assembly dock where Ariane's three rocket stages are wedged into an explosive *ménage à trois*; and a second, brand new launch pad, ELA-2, designed not only to increase the rate of launches to a maximum of ten per year but also to accommodate future generations of the versatile Ariane launch vehicle.

Jean Michel Desobeau, manager of payload facilities for Arianespace at Kourou, says it most unabashedly: "ELA-2," he sighs, "is simply the most beautiful launch pad in the world."

Be that as it may, the more surprising aspect of the center remains its location: steamy French Guiana. The recipient of an average of 110 inches of rain per year, it is a densely vegetated, thinly populated equatorial region that offers little in the way of logistical support for an enterprise so technologically demanding. Everything required for operations, whether computers, satellites, or rocket fuel, arrives either by air or ship in Cayenne and is then trucked to Kourou. For the European Space Agency and Arianespace, however, the advantages of launching from French Guiana far outweigh the costs of maintaining a cumbersome supply line.



A lone buyer ventures out into the midday heat near the town hall of St. Laurent du Maroni (above).



Members of the Hmong tribe have come from Laos to farm the central highlands, where they feel at home (left). Wayana Indians near Cayenne prepare for a feast by painting on colorful pastes (right).

The Ariane's coastal site is ideal: launch tracks head east and cross the equator halfway to Africa (below).





With political considerations in the mid-sixties precluding continued French space activity in the Algerian Sahara where it initially began, France's National Center for Space Studies (CNES) embarked on finding a new site, weigh-

Antennas on the haze-shrouded peak of Montagne des Peres link orbiting satellites to ground stations.

ing such candidates as the Seychelles, Mauritania, Madagascar, Ceylon, and Djibouti. Beyond logistics, the selection criteria included political, geological, and meteorological stability, low population density, east and north launch avenues to achieve both equatorial and polar orbits, and proximity to the equator. The last factor was especially significant, because it would make a rocket's job easier. For one thing, the surface of

the Earth literally moves faster at the equator than at higher latitudes. The extra spin therefore gives the rocket a centrifugal boost, helping it achieve the velocity needed to escape gravity's tug. Thus the rocket needs less fuel to carry more payload. For example, a rocket launched from Kourou can carry about 10 percent more payload than its twin launched from Cape Canaveral.

By 1967 CNES had picked French



A readied Ariane moves from the assembly building in the distance to launch pads and their gantries.

Guiana, poor though it seemed in resources and infrastructure. Accordingly, a period of building roads and bridges followed. In Cayenne the harbor was deepened and the runways of the airport lengthened. By 1968 the first sounding rockets were lofted from the rudimentary space center, paving the way for the arrival, some ten years later, of the first Ariane launcher.

In the years since, French Guiana's low population density has remained unchanged despite the influx of European technicians. Except on the highway between Cayenne and Kourou, or the one that stretches up to St. Laurent, to travel its few roads is more often than not an exercise in solitude. At the same time, however, not far from Kourou it is often possible to see curls of smoke rising from distant plots of land. Here local people practice slash-and-burn agriculture, still a reasonably efficient way to make room for a seasonal crop. Such people are likely to be either remnant Amerindians, indigenous hunting groups who continue to dwindle in numbers because of their vulnerability to European diseases, or the descendants of West African slaves brought to the Guianas in the eighteenth and nineteenth centuries by British, French, and Dutch colonists. To the west in Surinam (formerly Dutch Guiana), many of these slaves escaped from the mines and plantations and fled into the jungle where they established their own societies, still maintained and still fundamentally West African in culture. In recent decades, however, many of these blacks have crossed into French Guiana, settled either in Cayenne, Kourou, or St. Laurent, and entered into the often painful process of acculturation.

An even more exotic group occupies a cleared section of highlands around the village of Cacao. These are the Hmong, members of a Laotian mountain tribe invited by the French in the early

Computers at the control center, located seven miles from the pad, watch over the entire launch sequence.

CNES





Satellites meet various payload adapters during assembly. The Ariane's payload capsule can carry two satellites. Here, the upper one is being installed.

seventies to establish an agricultural community in the interior. In terms of climate and elevation, their new home matches the one they left behind in Laos, though one French official acknowledges that "they miss elephants." But if the Hmong don't have elephants, they have Toyota pickups and twice a week they truck produce to an open-air market in Kourou, where they sell fresh green beans, tomatoes, melons, and passion fruit, among other delectations.

Despite such ethnic local color, however, the primary hue is contemporary French. It suffuses the resident community in Kourou as well as the operation of the space center and the launches themselves. White, four-liter Renaults from the motor pool dominate Highway

1 and red table wine is as much a fixture of the center's lunch room as lavender bikinis are on the beach. No element, however, says "France" so emphatically as the presence, in Kourou, of the crack Third Regiment of the French Foreign Legion. Responsible for the space center's external security, their uniforms and ribbons bristle with the evocations of past campaigns: Indochina, Algeria, Tunisia, Chad. One or another of the regiment's companies are now almost always involved in jungle training, with maneuvers in the Guianese rain forest often lasting as long as forty days. Such evident and legendary toughness notwithstanding, however, there is another, rarely glimpsed side of the Legion that became apparent in the Officers Mess in Kourou not long ago. To a civilian guest, lunch seemed a ballet of protocol, civility, and grace. Salutes, introductions, and exquisite timing marked the four-course meal, as did war stories and a first-rate Bordeaux, vinted, bottled, and labeled in France

exclusively for the Foreign Legion, wherever on the globe it might happen to find itself.

Or almost wherever, for no Foreign Legion wine appeared on St. Joseph Island, although two enlisted legionnaires are posted there, ostensibly to keep watch. St. Joseph is one of the three Salut Islands 15 kilometers out from Kourou that comprise the infamous entity known as Devil's Island, the penal colony that for decades, in the French mind at least, caused the name Cayenne to be regarded as synonymous with the word prison. (In the opinion of one Arianespace employee, this accounts for the notable lack of tourists from France. The real reason, more than likely, is that Guiana's coastal waters are murky from discharged river silt that ocean currents do not flush. In Martinique and Guadeloupe, on the other hand, you can see hundreds of feet down, and therefore thousands of French tourists.)

Devil's Island, the smallest of the off-shore group, is completely abandoned, whereas Royale, the largest, still bears the remains of cell blocks and administrative quarters. Though the island is tranquil now, supporting a small hotel and overseen by a lighthouse-keeper who is a French civil servant with a degree in optics, a melancholy air persists, wafting around what is left of the insane asylum and over the crumbling headstones in the cemeteries. And while vines and roots today strangle the solitary confinement cells, it is not difficult to imagine their walls unbroken and their dark, cramped interiors inhabited by lost souls, such as Alfred Dreyfus or the legendary Papillon. In 1938 France ceased sending prisoners overseas but, because of the complications of World War II, the last inmate wasn't released until 1947. He is reputedly still alive and living quietly in Cayenne.

Ironically enough, the islands lie almost directly in Ariane's flight path. As a result, one of the first outward signs that a launch is imminent is the order to evacuate. The boat ferrying employees and the handful of residents leaves for the mainland in mid-afternoon, since

The Ariane's first stage, here in the assembly tower, houses four Viking main engines and their fuel tanks.





The unspoiled and primitive countryside offers stark contrast to Kourou's technology. Rivers like the Iracoubo provide the backcountry's major highways (above). And downtown Kourou's market runs at its own unhurried pace (below).

launches are generally scheduled for nine in the evening when astronomical conditions are best. It is also mid-afternoon on launch day when the presence of the Foreign Legion becomes more noticeable along Highway 1, their vehicles prowling relentlessly up and down.

Two hours before launch they will close the highway, except to space center personnel, VIPs, and official observers, though these will be carefully shepherded. It is also rumored, but not confirmed, that foot patrols are dispatched throughout the day into the savannah surrounding the launch site.

At about 3 p.m., the gantry on ELA-2 will withdraw, leaving Ariane attached to the umbilical tower only by feeder cords for electrical power and the supercooled fuel. By now Jupiter, the main control center 15 kilometers away, and Uranus, the monitoring blockhouse a scant one kilometer away, will be fully manned, tension not yet at full pitch. The countdown clock, however, will be ticking.

At seven o'clock—as indeed happened on March 19—a fleet of buses filled with observers leaves the Hôtel des Roche near downtown Kourou. The buses are in every respect unremarkable save one: gas masks drape each seat. Once under way, an attendant demonstrates their use. In the event of a launch explosion, the area would be engulfed in a deadly fog of nitrogen tetroxide, the stuff of rocket fuel.

By 7:30, after passing a Legion



checkpoint, the buses disgorge their passengers at Toucan, a large observation pavilion three kilometers from ELA-2 with an unobstructed view. Several television monitors inside display the countdown clock, show the controllers at Jupiter and Uranus intent at their consoles, and every few minutes zoom in on the gleaming white rocket. Hors d'oeuvres and éclairs are served; drinks are on the house.

The sky is overcast but breaks occur here and there, as do sprinkles. The women, mostly French, are dressed to the teeth. The event, at times, seems more like an art opening than a satellite

launch. Paris again. Even the commander of the Third Regiment, Colonel Piquemal, is here, crisp in pressed khaki and brilliant in his St. Cyr manners. A few other officers are also present, though some are clad in battle fatigues and look like lethal green jaguars. Despite the amenities and the chit-chat, every mind is tuned to the clock.

At T-minus-six minutes, Ariane is switched from manual control to computer control. Except for the safety officer who can intervene with his destruct button at any time, Ariane is now fully automatic. An expectant buzz runs around Toucan. Some of the Americans,

seeing the TV cameras dwelling on the controllers at Jupiter and Uranus, wonder whether controllers at Canaveral or Houston are allowed to smoke that much at their consoles. A hint of recalled American puritanism creeps in.

The countdown proceeds without a hitch. By now everyone has abandoned

French Guiana is now an escape route to space, but France once used Devil's Island as a prison. This tower in Kourou served to help keep tabs on the infamous Alfred Dreyfus, an army officer later cleared of spying.



Arianespace on the Move

Like the atmosphere in the dressing room of an understudy asked on short notice to take over the star's role, a mixture of excitement and apprehension pervades the new headquarters of Arianespace, set symbolically in the futuristic town of Evry on the outskirts of Paris.

Emotions peaked on the evening of March 28, the date set for the seventeenth launch of the Ariane rocket and its \$210 million payload of two communications satellites. The launch had already been postponed several times, on the last occasion only seconds before ignition. Thus it was high drama as television monitors displayed the Ariane's liftoff—the images transmitted directly from the Kourou launch site in French Guiana to an assembly of company employees, journalists, and guests, including potential customers.

Adding to the tension, Arianespace officials had not been slow to grasp the opportunities created by the explosion of the *Challenger* and the subsequent grounding of the U.S. space-shuttle fleet. The company began discussions almost immediately with various shuttle customers facing prospects of long and costly launch delays, to see if they could be accommodated in the Ariane's schedule.

Arianespace found a number of takers. For example, the International Telecommunications Satellite Organization switched the launch of its first Intelsat 6 satellite from the shuttle to the Ariane, although for now Intelsat still plans to use the shuttle to orbit some of the other four satellites in the series. And the Japanese company Space Communications recently reserved two launch slots in 1988, which was especially sweet for Arianespace, since last September it had lost out to NASA after some hard bargaining.

Even before the rush, though, things were looking good. Profits of \$25 million last year—on a turnover of \$203 million—completed a five-year climb to make Arianespace the twelfth-largest exporting company in France. Business is expected to double this year, and the company already has contracts to launch 30 satellites by the end of 1988, worth \$1.23 billion.

The figures are now expected to go considerably higher. Arianespace president Frédéric d'Allest, who is also director-general of France's national space agency, announced in late February that his company could make room for eight more launches in 1987 and 1988. The figures were slightly illusory, as some of the offerings were merely unfilled slots resulting from an initially lower demand than predicted.

Nevertheless, d'Allest is keen to empha-

size that the Ariane is no longer a junior player in the launcher business, calling it a "valuable asset to be put at the disposal of the western world" as a proven complement to the shuttle. The hope, he adds, is that "American customers will turn to Arianespace just as Europeans used U.S. launch capabilities at the time of the early Ariane failures." The company is also looking more aggressively to Japan, and has recently opened an office in Tokyo.

The Ariane's supporters see NASA's woes as vindicating their earlier arguments—often against fierce opposition—about the wisdom of heavy European reliance on the U.S. shuttle program. "The accident will certainly strengthen the hand of those who say we need to maintain the option of expendable launchers," says Sir Roy Gibson, former director-general of the European Space Agency (ESA), which helped develop the Ariane, and now head of Britain's new national space center.

The new commercial climate is also likely to reinforce ESA's commitment to developing an advanced version of the rocket—Ariane 5—which will be powerful enough to ferry more than eight tons into geostationary orbit and 16 tons into lower orbit. That's enough to carry the Hermès manned spaceplane being pushed by France. Although ESA's member states have already approved work on a sophisticated cryogenic-fuel engine and have targeted a launch date of 1995, they have not formally endorsed the rocket itself.

At the same time, some Arianespace officials express concern that the *Challenger* misfortune could dampen the commercial enthusiasm for space ventures in general on both sides of the Atlantic, although spokesman Claude Sanchez says that "so far this has not shown itself." More practically, the various problems of U.S. space shuttles and the Ariane rockets—three failures so far—could push insurance costs to exorbitant levels. Premiums already account for up to 35 percent of the cost of the satellite itself and have become a major disincentive to customers. Arianespace has tried to meet this by setting up its own reinsurance company to cover the portion of risk from liftoff to when the satellite is kicked into orbit.

With the eyes of potential clients fixed more firmly than ever on the Ariane's performance—even after the successful March launch—officials are well aware that a false step could have more serious commercial consequences than in the past. Arianespace is now aiming for a success rate of about 94 percent, says president d'Allest. "Based on our experience so far, there is no reason why we should not be able to achieve it."

—David Dickson

CNES





Night launches are quite the norm, because the Earth's rotation and other factors are most favorable then.

the monitors and crowded to the pavilion's rails to see the real thing, feel the earth shake. Many train binoculars on ELA-2, fearing they will miss something with the naked eye.

Quatre, trois, deux, un. Ignition...

Alas, nothing happens. Ariane remains mute on the launch pad. Only a well-known French expletive pierces the air.

An electrical relay switch designed to activate withdrawal of the fuel cord on ELA-2 operated a few milliseconds too slowly to satisfy computer control, which proceeded to abort the launch, as it was programmed to do. It is the third time that this seventeenth launch of Ariane has been delayed. The guests at Toucan board their buses in a dejected mood and head back to the hotel. The champagne goes unserved.

But the next morning Charles Bigot, managing director of Arianespace, is beaming. "We lost nothing except a little time," he announces. "Our safety system worked." He is right, for atop the rocket still sit two intact communications satellites—Brasilsat 2 and GTE's GSTAR 2—requiring only continued air conditioning and battery charging to stay viable. With a combined worth exceeding \$210 million, it was the better of wisdom—albeit in this case computer-generated wisdom—to keep them waiting.

Eleven days later, in a rainshower and with far fewer guests assembled, Ariane rose flawlessly from ELA-2 and within 15 seconds disappeared into the clouds. Thirty minutes later, telemetry confirmed that both satellites had achieved their projected orbits. Champagne flowed at Jupiter and Uranus and cameras caught controllers lighting up cigars, quite possibly Havanas.

That night in Cayenne at La Belle Époque, the chanteuse undoubtedly went through her torchy repertoire, puffed on her usual Gitane, and adjusted now and again the blossom in her hair. That night too, for Arianespace, it might well have been said that *La belle époque est arrivée*—the good old times have arrived. —

The Battle of Bowman

The enemy: towering summer storm clouds harboring hail factories. The defenders: a band of pilots flying a handful of well-worn airplanes.

By Carl A. Posey

Meadowlarks are singing, and now and then you hear the cough of an engine struggling to start, hammering for a time before it dies to silence on the ramp. Tools clatter. Voices rise and fall against the thump of radio rock filling the hangar. Outside, the wind ripples the deep grasses, quartering nervously back and forth, southeast to southwest. The people here tell you this nervous gusting lies always athwart the narrow, gray-streaked runway.

On this hot day at the airport in Bowman, North Dakota, more is in the air than an uncertain wind pushing up from the south. The workers now and then glance up from their patch of aluminum, their engine, their wing-mounted pyrotechnic hardware, their Travis McGee, to return the glare of the sky.

The clear sky. It's more than cloudless—it wears a blue that seems never to have heard of moisture. And yet, everyone knows that moisture is there, somewhere far upwind. Everyone is trapped in the irony that, in this near-desert of black loam, where *any* moisture is a balm, one form of water—hail—is a mortal enemy, the enemy they must fight later in the day.

They work methodically, watching the sky and seemingly testing the hot currents that now steady from the south and west. Headquarters in Bismarck has already said this would be a "Go" day, based on earlier atmospheric balloon soundings. So they know that, in a few hours, the cloudy placenta in which their enemy begins to stir will drift within

range of their small aircraft. They will meet it in airplanes of a type no longer manufactured, bought new back when this war began. And borne on wings laden with the weapons of this running fight, in skirmishes that last well past midnight, they will try to throttle the mechanism by which tiny droplets of water grow into a cruel, crop-smashing barrage of hail.

The work is called weather modification, a somewhat more distinguished offspring of the old high-plains rainmakers, to use a term that gives modern practitioners the shudders. "In dry years, people ask us if we're stealing the rain," says Lynn Rose, the boyish Oklahoman who directs the North Dakota Weather Modification Board. "In this business, you always get this 1950 entrepreneur-type cloudbuster talk coming back to haunt you."

Stressing that his cloud-seeding program is intended to mitigate crop damage caused by hail, and not to change rainfall, Rose acknowledges that they do in fact see a slight increase in rain, of perhaps 7 to 10 percent. "But we also see a 20 to 30 percent decrease in hail damage as listed in the actuarial records," he says. "That's why individual farmers keep the program going."

It is a remarkable statement. Weather modifiers have always had the problem of proving that they produce *any* result, let alone a positive one. The enormous variability of the atmosphere has almost always proved too much for statistical methodology—only in a few



Jim Brandenburg

cases, all arguable, have scientists identified the faint human signal in the fluid-dynamic chaos of a seeded atmosphere. Cloud seeders may see more rainfall, weaker winds in a hurricane, differences in snowfall; but proving that what they see came about through the hand of man, and not the offhand whim of nature, has been ruinously difficult. Actuarial tables are another matter. A farmer actually sees his hail risk shrinking, along with the insurance premiums he pays for protection from this arch-destroyer of crops.

More remarkable is the fact that North Dakotans *vote* for cloud seeding and pay for much of it themselves. Despite the prosperous trappings of science—in the form, for example, of a continuing study of the North Dakota results by the National Oceanic and Atmospheric Administration—the operational side of the program is funded



Jim Brandenburg



Piper Twin Comanches confront the aerial forces of nature. The enemy is crop-destroying hail (above).

North Dakota's Bowman Airport is equipped with a mobile radar unit to track troublesome clouds (left).



The University of North Dakota's high-tech weather laboratory provides technical backup to the warriors.

mainly through self-inflicted levies imposed by counties that vote to have a hail-mitigation project. These referenda rule on the project every two years, matching a biennial appropriation of about \$750,000 from the state to support the weather-modification board.

There have been only four years since 1951 without any weather modification in the state, and since 1961 enough counties have voted yes to keep the work going. This is not to say weather modification does not sometimes rub against environmentalist or fundamentalist sensibilities in North Dakota, but there is sufficient belief in the program—or perhaps sufficient fear of what hail can do to a harvest—to keep people voting for its continuation.

The project is now funded through June 1987. This year, the June-through-August seeding operation will cover six counties. Appropriately, they have

names that sound like battlefields—McKenzie, Mountrail, and Ward in the north, and Slope, Hettinger, and Bowman in the state's southwest corner.

When this work began in North Dakota, weather modification was one of the favored offspring of government science. Back in the 1960s and 1970s, you could regularly read of major projects to enhance rainfall from cumulus clouds in Florida, mitigate hurricane winds, adjust snowfall (less for Buffalo, more for the Sierra Nevada), and even pull the plug on serious lightning bolts. A national hail-suppression experiment, modeled on seeding techniques developed in the Soviet Union, tried valiantly to defeat the icy pellets over the wheat lands of northeastern Colorado. And states such as South Dakota had projects of their own, both to increase rainfall and to reduce hail damage.

Now, many seasons and millions of dollars later, most of these have vanished, poisoned by lethal combinations of bad theory, statistically improbable results, politics, and personalities. From this general wreckage, North Dakota's project has emerged as one of the few credible weather-modification efforts in the United States. A vestigial seeding effort continues in Harding County, South Dakota, which abuts Bowman County and contracts with North Dakota for meteorological support. The national hail experiment was finally dropped, although the Russians, who use antiaircraft guns and modified rockets instead of airplanes to carry seeding material into the clouds, are "still banging away," Rose says with a smile. He adds, more seriously, "The problem is targeting—when you shoot the stuff up from the ground, you can't really see where you need to seed."

Indeed, weather modification seems to be more popular in other countries, a fact that Rose doesn't overlook. "We have a pretty rich interaction with people overseas," he says. In late 1983, North Dakota was visited by Moroccan scientists planning a seeding program in the Atlas Mountains, hoping to transform that arid coastline into something more like California. Yugoslav scientists toured the project a few years ago, with an eye to designing their own modification program without taking the Soviet ground-based approach. At a recent in-

ternational meeting in France, Rose shared his techniques and positive results with an enthusiastic audience. And there is an ongoing multi-million-dollar seeding project in Greece. "You won't see many pilots here from previous summers," Rose says, sweeping his arm around the airfield. "Most of them went to Greece." It is another reminder that big-money weather modification has mostly crossed the waters.

Those pilots who are here, however, will scramble at about four o'clock this afternoon—as part of the tiny air force belonging to Weather Modification, Incorporated, the company headquartered in downtown Bowman that carries out the cloud seeding. For now, there is

much work to do to get ready.

Finally, it's time. From Bowman's airport, a radar-equipped Cessna 340 and two Piper Twin Comanches rise to confront the advancing (but still embryonic) hail clouds. Another Twin Comanche flies in from Sidney, Montana, just across the state line, two from Watford City, and one each from Parshall and Minot. A second Cessna 340 takes off from Williston. And from Dickinson, the seeders are joined by a research flagship—a heavily instrumented Cessna Citation II, operated by the University of North Dakota's burgeoning aerospace department.

In fact, these afternoon encounters with hail and heavy weather are more

than just a laboratory for cloud seeders—they are also a kind of incubator for weather-modification pilots. "The pilots gradually rotate," explains Rose. "They stop off in Bowman en route to a flying career. They study at the university, taking a course called Weather Modification Pilot Training—two semesters, plus credit for field work. They fly in our seeding programs as interns, serving as right-seat pilots one year, coming back as pilots in command the next. Some stay two, three years. This year they're maybe a little greener than in the past, because of Greece."

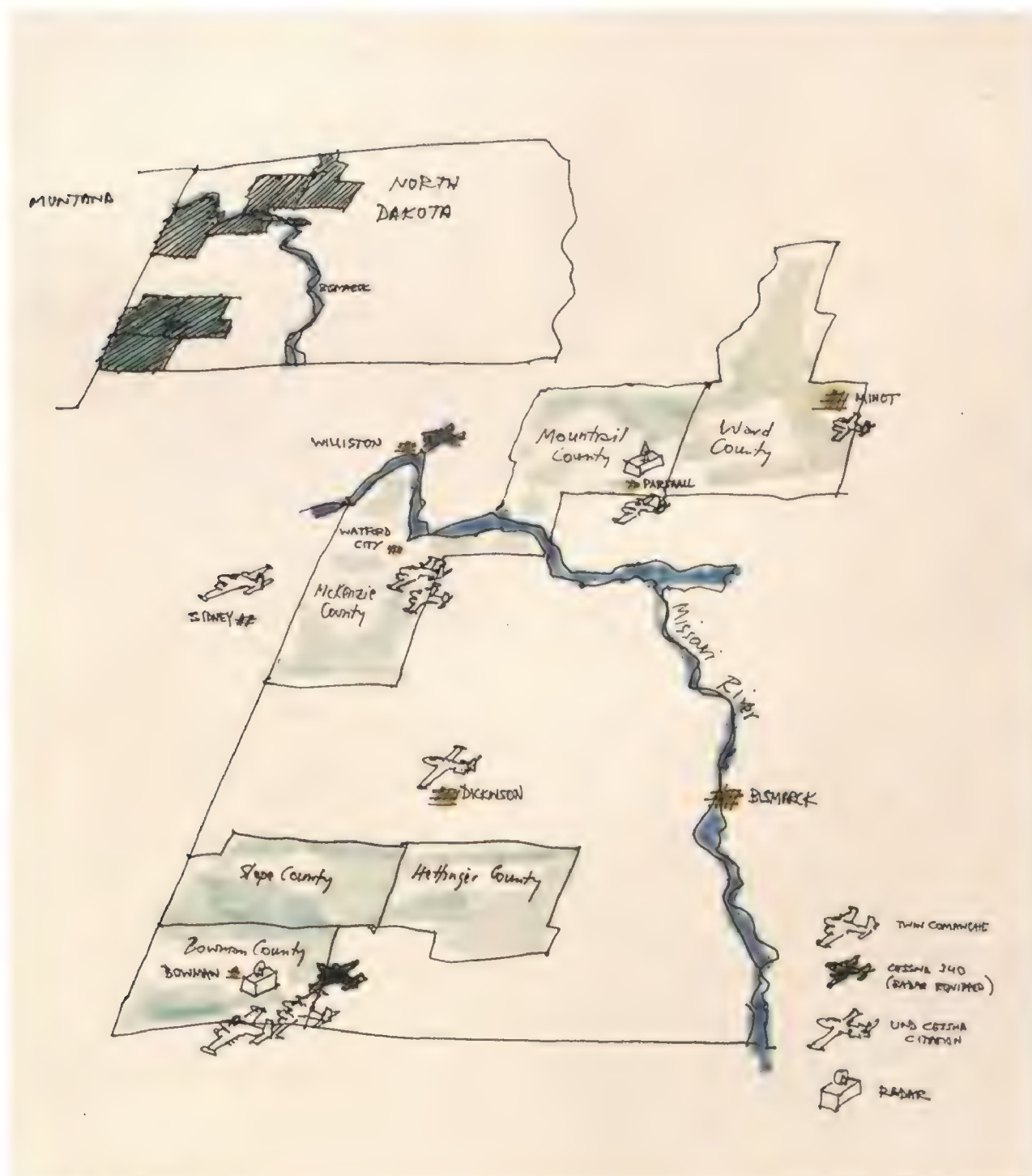
Green or not, the young pilots converge on the developing storm in aircraft built for almost anything else but flying through heavy weather. As they enter the veiled realm of the enemy, they plan their strategies. What's the best way to seed: at the cloud base so updrafts can carry the seeding material—called "the agent"—up into the cloud, or by penetration flights, putting the agent directly into the turbulent interior? Should we approach from the front or the back? Which works better? Which is safest?

What they want to do is find and seed not the violent, mature storm cell, but the new cloud growth around it—the feeder cells and line clouds that will eventually grow into towering hail factories. Hailstones are formed when small ice particles and supercooled water—water cooled below freezing but still in liquid form—are carried on updrafts to very high altitudes. There, successive coatings of the supercooled water rapidly transform the small particles into large, damaging chunks of ice.

"So to block the hail-formation process," Rose says, "it's a matter of keeping large quantities of liquid water from being carried too high in the mature storm cell." Inoculating the cloud with silver iodide will add millions of crystalline nuclei—the seeds—around which supercooled water can freeze. Freezing the water, the hypothesis goes, robs the hail-forming process of the liquid water that would otherwise coat and recoat the growing hailstones.

But the term "hypothesis" here would sound pretentious to its father, Wilbur Brewer, president of Weather Modification, Inc. He might argue that necessity, not science, was the mother

The residents of six North Dakota counties are impressed enough with the results of cloud seeding that they help foot the bill for each year's aerial sorties.



Drawing by Carl Posey

of his invention. As Rose puts it, "Wilbur Brewer developed a process, whether he knew it at the time or not, that focused on new growth areas in the clouds. We work on a small cloud that will build up to become the main updraft of a thunderstorm. It's really a seat-of-the-pants design, but it works."

To Brewer, necessity took the form of catastrophic hail damage, summer in and summer out. During the 1950s, southwestern North Dakota had the highest hail losses in the United States. "You got crop losses of maybe four percent in the Carolinas, and down in the cotton areas of Texas and Oklahoma five percent was considered high," Rose notes. "But up here in the Dakotas and Colorado you were looking at losses of 6

to 12 percent. So the farmers and neighbors in six townships turned to weather modification." As one longtime farmer and supporter of cloud seeding explained, "Hail goes through wheat just like a scythe. My dad got hailed out regularly, and I've been hailed out four times in 20 years."

Which leads to today's mission. To an air-traffic controller watching the action on his radar screen, some of the blips seem to be flying right into the big storm cells that he normally takes pains to route most traffic around. But a participant looking through the windscreen of a Twin Comanche sees that the "blips" are carefully threading their way between the big cells, flying the gray-and-silver valleys between clouds

as the pilots plan their attack.

The first airplane probes the feeder clouds to determine how and where to lay the trails of seeding agent and where to plant the pyrotechnic flares. The seeders need to know how much of the water inside the cloud has already become ice and where the freezing level is, as well as the height and temperature of the cloud tops. Ideally, they begin to seed as the cloud evolves into a growing tower, which brings more water into the system and fosters the strong updrafts that will ultimately power the hail factory within. Some of the clouds to be seeded can be inoculated from beneath the cloud base, with the updraft scooping the agent up into the interior of the cloud. Others must be penetrated, the seeds laid in the turbulent boiler room of the developing storm.

A Twin Comanche heads in. Flipping a switch in the cockpit ignites the bomb-shaped acetone burners on each wing tip, which produce smoke rich in silver iodide. The flares containing more silver iodide are racked along the trailing edge of both wings, to be fired like depth charges. Now, as the light goes gray, as the windy hand of the storm grabs and shakes the little airplane, the first shots of this skirmish are fired. After a bit, the Twin Comanche breaks clear and banks for another pass . . .

On the air-traffic controller's radar, ten blips circle and dance along the line of budding thunderheads. While they weave back and forth, steadfastly sowing the clouds, the research team aboard the university's Citation makes its sampling runs, occasionally doing some high-altitude seeding as well.

There is great institutional pride in the high-tech Citation, but there is a special warm affection for the old Twin Comanches. "They are pretty tough little airplanes," says Rose, nodding his head toward them in respect. "The Twin-Cs are also very economical to fly, burning only about 15 gallons of fuel per hour. They will fly 150 mph even with all the stuff we hang on them, and still climb to 20,000 feet or so. We do penetrations into some serious clouds with them—a *lot* of penetrations." He pauses for a moment, and then adds, "You can't be dumb while you're flying one, though."

You can't be dumb flying anything in

Charles T. Muhs



Student interns from the University of North Dakota, such as David Stadum, are on around-the-clock call (above).

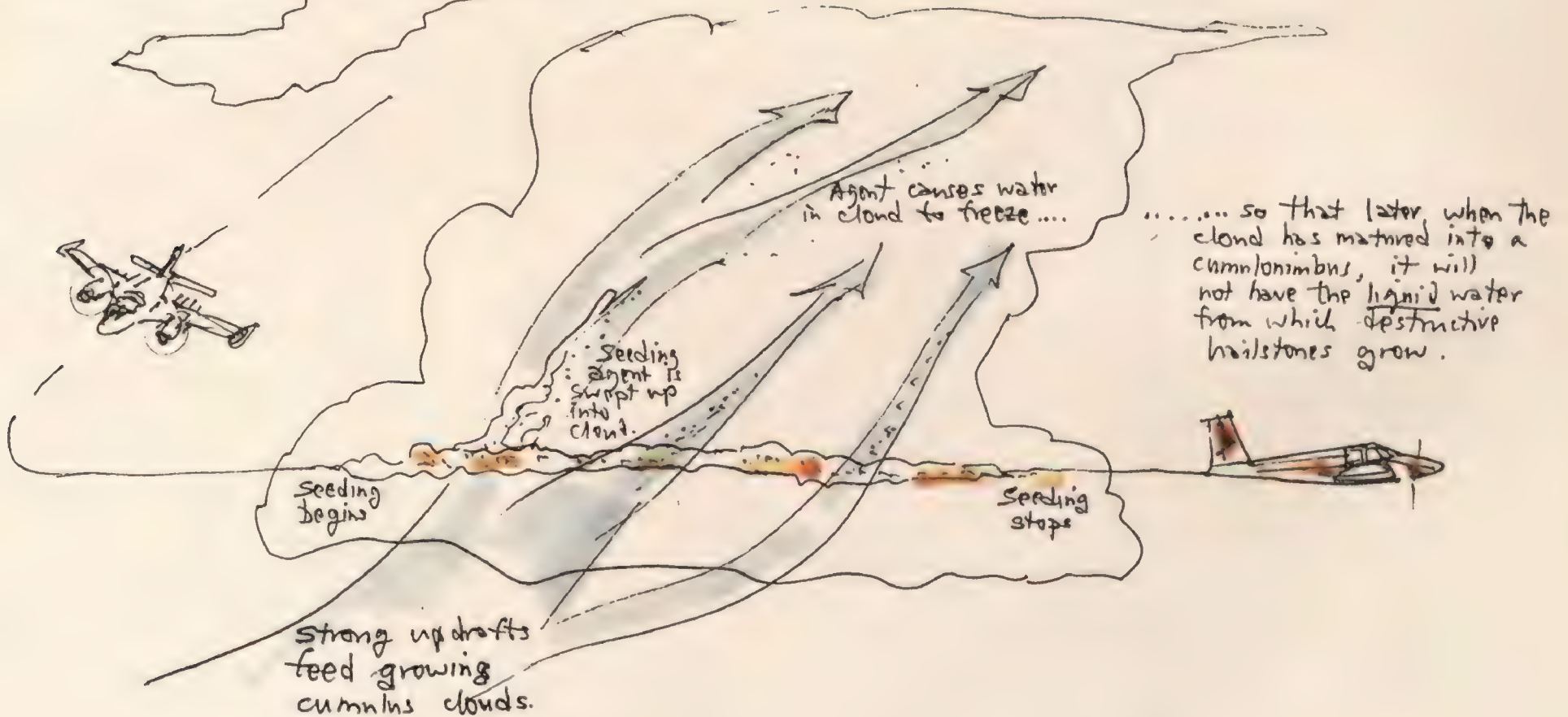
Carol Yocum installs flares that hold seeding agents, under the careful eye of instructor Jim Noeske (right).

Charles T. Muhs



The Enemy -
Left to themselves,
these young, growing
cumulus clouds
will become
towering hail
factories by
late
afternoon...

The Defense -
A fleet of seeding
airplanes - mostly
Twin Comanches,
armed
with seeding flares
and burners...



Battle lines are drawn, and forces charted, in the combat between pilots and hail-producing storms.

the environment of this skirmish, which this day lasts well beyond the late sunset of a northern summer, until 2 a.m. The airplanes stay aloft as long as they can, and seed as much as they can, then land, refuel, rearm, and return to the storm. When supercooled water in the cloud threatens to turn them into big hailstones themselves, they retreat, let the ice flake off their wings and head back up to the fray. It is an exhausting world of hard flying and teeth-jarring turbulence. One pilot recalls a line of "back-seeders"—growing cloud towers moving into the main thunderstorm cell, best approached upwind—that was greeting the airplanes with updrafts and downdrafts of 3,000 feet per minute, and sheets of ice. Tough enough by day,

the job gets even worse at night.

"We do a lot of night work," Rose says. "But we don't fly penetrations after dark. The problem is that we're worried about the pilot losing his sense of where the big storm is in relation to his airplane. We just wouldn't want him to make a wrong turn and head into a severe storm cell. But we are getting closer to being able to fly nighttime penetrations." No doubt something for rookie underclassmen at the university to look forward to.

In all the long day's work, the airplanes add only a few pounds of seeding agent to the North Dakota sky. The object, says Rose, is not so much to deliver volume as to deliver lots of particles, in the right places, at the right time in the

hail-forming sequence. Success depends upon stimulating the water in the clouds to freeze. The water either must be given a nucleus to freeze around—a crystal of silver iodide, for example—or it must be cooled, as with dry ice, until it will freeze without a nucleus.

The cloud seeders in North Dakota take both routes. Rose says they use newly developed silver-iodide agents that promote freezing faster than earlier versions. But the group has been turning increasingly to dry ice. "The silver-iodide pyrotechnics don't work as fast as we used to think they did," he says. "And whether they work as desired depends critically on the amount of liquid water in the cloud as well as the temperature. Dry ice doesn't depend on

Charles T. Muhs



the temperature as much, which seems to make it more versatile."

They have also begun burning a new chemical mixture developed by scientists at Colorado State University in Fort Collins. This mix, which combines silver iodide and sodium chloride—table salt—produces many more nuclei per gram than existing chemical brews, and the salt apparently draws water vapor to the nuclei. "This means we go from a reaction time in promoting freezing of 30 minutes down to ten minutes or less," Rose explains. Such fast-acting chemicals are important because a strong updraft can spit the flares out the top of a cloud before the agent has had time to take effect.

Rose became director of the North

Dakota Weather Modification Board in 1977, bearing degrees in meteorology from the University of Oklahoma. His career in weather modification began in 1974, in what was then a strong cloud-seeding program in South Dakota.

Looking around him now, he stops and thinks back a moment. "You'd have gotten a much different impression of me when I started out," he says. "I thought weather modification was some brouhaha. Then I had a chance to really look at it up close. One day I seeded a cloud—we hit it with about 20 grams of silver iodide—and the top just popped off of it. We produced a nice rain shower from that cloud, during a drought. And the farmers on the ground got a nice crop out of it, too. That said to me:

there may be something to this.

"You know, you look at some of the other projects—for every correct way, there's probably a hundred incorrect ways to seed. But the evidence says there really is more to this than *rain-making*," Rose says, grimacing as he uses that term he hates. "And one thing to remember: weather modification is never irreversible. When you stop seeding, you stop the effect."

But there is hardly any chance that Rose or his long-running project will stop seeding, at least not as long as there are farmers who believe the seeders can ease the blight of hail on those world-feeding wheat fields, or there are young pilots and old Twin Comanches to fly in the Battle of Bowman. —

Jim Brandenburg



Wing-tip generators and pyrotechnic flares disperse millions of tiny silver-iodide crystals that interfere with the hail-forming process (above).

While billowing summer clouds may look beautiful, farmers often see them as nothing but economic trouble (left).



The world's most famous pilot and engine of human-powered airplanes has returned to earth...sort of.

By Stephan Wilkinson

Hollywood knows more about formulas than Dow Chemical ever will, and it has poured forth a torrent of ritualized "youth films" with reassuringly familiar plots and characters—the Jock, the Nerd, the Valley Girl, the Misunderstood Greaser. There are parts in all of them for the young Bryan Allen, who could play the lead in *Breaking Away to the Future II*, a film set in a small farming community in central California. Allen would be the skinny, slope-shouldered, near-sighted kid with the schoolteacher father—an indignity any preacher's or teacher's child will confirm—who spends his time pedaling a 10-speed while the dudes are tuning their GTOs. ("I won the Homecoming Day bicycle race three times in a row," he today muses. "It was the one day a year I was normal: *everybody* was riding a bike.")

Allen then goes off to the California Institute of Technology—Nerd State, through celluloid eyes—to become a biologist, and he takes a job testing fertilizer on a huge corporate farm in the San Joaquin Valley. But the last reel hasn't unwound: he gets sidetracked and goes to work for a weird inventor named Paul MacCready, who comes up with history's first successful human-powered airplanes! And Bryan Allen, pedaling with the power of a linebacker, flies them

His pedal-plane fame may be fleeting, but Allen's joy in creating things, even bubbles, hasn't burst.

Who is Bryan Allen?

James Sugar/Black Star



into the pages of history.

He is featured in *Time* and *National Geographic*, gets a brass plaque from his high school honoring him "For His Contributions to Aviation" (in your face, Mister Touchdown), ends up on the lecture circuit, and gets the girl. It's a wrap. And it's all true. Allen did indeed grow up in a social sidestream in Tulare, California, a town that could have been the set for *American Graffiti*. And he did become pilot, powerplant, and one of the builders of the record-setting *Gossamer Condor* and *Gossamer Albatross*.

On August 23, 1977, Allen permanently widened his and aviation's horizons. Pedaling the shimmering *Gossamer Condor*, he completed the first human-powered flight over the mile-long course stipulated by Henry Kremer. For 18 years the British industrialist had offered an award—finally totaling \$86,000—for exactly that simple-sounding but in fact incredible accomplishment. Birds do it, bees do it,

By pedaling the Gossamer Albatross across the English Channel in 1979, Bryan Allen flew into history.

but not until MacCready's innovative engineering was matched to a superb engine—a 140-pound bicycle racer and hang-glider pilot who could produce a consistent one-half horsepower for minutes on end—did a human being do it.

"MacCready said, 'Let's build an airplane to win the Kremer Award,'" Allen explains, "rather than, 'Let's build an absolutely wonderful human-powered airplane.'" While the British teams were trying to bludgeon their way to success through sophistication, MacCready chose the cheapest and easiest course. He was willing to build an extreme machine that would be very limited and impractical but that *would* win the prize." In a sense it was exactly the route that Charles Lindbergh had chosen when he created an unstable, im-



James Sugar/Black Star

Unable to stay snugly earthbound, Allen helped devise the White Dwarf, perhaps the Model T of "sport blimps."

practical, single-seat, nearly windowless airplane that could be constructed quickly with but one mission in mind.

Two years later, in June 1979, Allen spent an agonizing two hours and 49 minutes pedaling MacCready's next creation, the *Gossamer Albatross*, from

Folkestone, England, to a misty French beach. He won the MacCready team a second Kremer award—this one worth \$210,000 for the first human-powered flight across the English Channel—and entered the pantheon of competitors who have asked more of their muscles



than seems humanly possible.

Allen, who may be the most unassuming superathlete in the history of sweat, has had no problem turning his back on instant notoriety. "It was fun dealing with fame for about a year, which was all I intended before going back to ob-

scurity," he says. "I felt I'd taken time off—not accomplished anything, not built anything."

After a brief career as the public-affairs manager of a company making ultralight airplanes in New Mexico, Allen went back to building things, at the

Watson Model Works, a laid-back workshop on a side street near Van Nuys Airport, in Los Angeles. There, Allen and Bill Watson, a friend from the MacCready days, make stage props for the comedian Gallagher, a prince of craziness whose wildly popular act consists

Before tackling the English Channel, Allen and the Albatross practiced over Harper's Dry Lake in California.

A superb engine for human-powered aircraft, the 140-pound Allen churns out a steady one-half horsepower.



James Sugar/Black Star

largely of word-play toys, food fights, and the launching of ludicrous missiles into the audience.

The styrofoam flying objects—watermelons, fish, elephant tongues, a dollar-sign-shaped bird called an s-crow—flow seemingly unbounded from Allen's



Peggy Darnell

childlike enthusiasm. (In his little office, there is a congratulations-on-your-new-job card from a friend. It shows a young man riding an oversize tricycle, and the legend reads, "The secret of staying young is finding an age you really like and sticking with it.")

There is something strangely fitting in Allen working at the beck of a comedian. Not only does he have a sense of humor that allows him to see absurdity in what others take seriously, but his own *Gossamer Albatross* flight danced around the edge of hilarity itself. Had



Gallagher been the sponsor, we'd have fallen down laughing at the spectacle of a half-dressed man in horn-rims and plastic helmet riding a Saran-wrapped bicycle across the English Channel.

From the ceiling and walls of the shop hang a dizzying variety of vehicles de-

signed by Watson and Allen—from a pedalboat faster than most sailboats to a bicycle designed for up-hill races only—that look like they're waiting for the Three Stooges to come along and take them for a spin. But visible here and there amid all the goofiness are some of

the components of an aircraft that weds Allen firmly if irreverently to his famous past. The White Dwarf is a 47.5-foot-long human-powered blimp, in which Allen has already set two world records: for flight distance and duration for small airships, *including* those with engines.

On their own version of a bicycle built for two, Allen ponders while his shop partner, Bill Watson, pedals. The two are friends from Gossamer days.

He powered the turnip-shaped craft from Thermal to Brawley, California, covering 58.08 miles in eight hours and 50 minutes. Allen spent the time pedaling lazily—"I was way out of shape," he says—and holding shouted conversations with baffled long-distance truckers on the highway that paralleled his route.

The White Dwarf has also helped convince him that his earlier human-powered deeds were perhaps misdirected. Henry Kremer's money was the carrot that led experimenters such as Paul MacCready to a remarkable variety of carbohydrate-fueled accomplishments, but the rules forbade the use of lighter-than-air gases for lift. "Isn't that ridiculous?" Allen asks. "It's as though somebody said, 'You have to travel from here to there, but you have to crawl.' Or as though somebody had a literary contest that would only accept hand-written entries on homemade paper."

The designers of the nearly 60 human-powered airplanes built since the Kremer awards were first announced might disagree, and the state of muscle-plane aviation advances because of them. MacCready has gone on to build superlight airplanes powered by solar energy. A team of students at the Massachusetts Institute of Technology built a craft that recently won a Kremer prize for speed, flying a 1,500-meter course at approximately 20 mph, using the pilot's leg-power as well as his energy stored in a battery via a pedal-driven generator shortly before the flight. The team is now organizing an attempt to fly a human-powered airplane from the island of Crete to the Greek mainland—the nearly 70 miles that were the downfall of Icarus and his feathered wings. And a West German team has built an airplane so sophisticated that it was able to best the M.I.T. team's speed record on pedal power alone, with no stored energy.

Allen sees the pedal-driven White Dwarf as the prototype of a new class of "sport blimps" that could make human-powered flight . . . well not exactly *practical*, at a potential \$40,000 per copy



James Sugar/Black Star

and a bulk that requires renting a small hangar, but more attainable than it is through the use of fragile, labor-intensive aircraft such as the *Gossamers*. The blimp is a robust little sausage, and its suspension cables, aluminum-tube keel, and fittings have all been tested to

five Gs—about three times the strength of the flimsy craft in which Allen made history. Indeed, the White Dwarf has been flown by pedalers as heavy as 250 pounds and in breezes that would turn a human-powered airplane into a plastic tumbleweed. (He and Watson are also



Peggy Darnell

Allen (right) and other crew members of the Albatross team try another form of human-powered flight between tests.

developing a slightly larger two-seat sport blimp powered by a pair of fist-sized model-airplane engines.)

Growing up in Tulare, Allen would ride his bike to the US 99 overpass and watch cars flowing north past a sign that read "Vancouver, 1,017 miles." He

would imagine that perhaps one of those very cars was actually making that journey. The White Dwarf is yet another reflection of the childlike desire for simple freedom and uncomplicated mobility that seems to have driven Bryan Allen ever since. ➔

Airline Deregulation is Working

By Joan Feldman

The Airline Deregulation Act has accomplished what it set out to do. With the passage of the Act in 1978, the U.S. government decreed that airline tickets should be sold to the public just as commodities from soap to home appliances are: without government interference of any kind. This profound alteration in the air-travel industry has been a boon to individual travelers, who have gained greatly expanded access to economical air travel. The fundamental premise behind the move to deregulate the airlines was that passengers would get more value for their travel dollars—and that is exactly what has occurred.

That deregulation would succeed comes as no surprise to some members of the industry who favored it early in the game. They include companies such as United Airlines and Texas International (now merged into Texas Air Corporation, a holding company that owns Continental, New York Air, and, depending on governmental and shareholder approval, Eastern Airlines), who saw the opportunity to gain on the competition once federal protection was stripped away. Most economists insisted that a free market in air travel, as in other industries, would boost efficiency. Consumer advocates agreed, arguing that air travelers were paying too much. A number of entrepreneurs, sniffing the opportunity to make mincemeat out of some tired, old airlines that were hanging on solely because of the protection afforded by regulation, lobbied in favor of change. And politicians from both parties, envisioning a harvest of votes from a field in which lower fares would prevail, added to the growing clamor for a fresh start.

Despite the momentum, however, there were many who predicted that actual competition would “mean the destruction of the best air-transportation system in the world”—a phrase which, along with others similarly worded, revealed the worst fears of many individuals and groups who knew that their lives would no longer be so comfortable. To hear these people talk about deregulation, you would have thought the very core of Western civilization was threatened.

But what those recalcitrants left unsaid was that the system, as it stood, was inefficient and unable to cope with the comparatively wild and unpredictable forces of a free market. Trade

More Americans are going to more cities for less money as the new era of open markets in air travel takes off.

unions opposed passage of the Act because they knew the high wages they enjoyed over the years, thanks to a protected fare system that guaranteed sufficient revenues to meet costs and add a profit, would not hold up in open competition. Mayors and civic leaders from small cities feared the Act because they thought they would lose the service of the large carriers, many of which had been forced into serving them in the first place. Wall Street didn't like losing a risk-free industry offering a predictable investment, with the returns virtually government-guaranteed. Travel agents were unhappy at the prospect of seeing an end to guaranteed commissions on high-fare tickets. And a lot of Washington attorneys could foresee their lucrative practices, based largely on the regulatory laws, going down the drain.

There is no denying that the Act created a precipitous change in a business climate that had been entrenched for decades. Big government had invaded the industry back in 1938, when the Civil Aeronautics Board (CAB) was established. Congress assigned the CAB several tasks, among them to protect the newly emerging airlines from destroying one another through fare competition (at that early stage in their formation, a legitimate worry), protect the interests of the passenger, and promote the growth of air transportation in general, even in remote areas that might not have expected to enjoy airline service.

The CAB literally *managed* the system: assigned routes, set fares, and allotted subsidy funds to encourage airlines to serve smaller cities that would have been unprofitable markets otherwise. As air travel became increasingly popular, though, the Board's responsibilities began to conflict with what would have been a normal evolution of a maturing industry. It continued to protect companies that no longer needed protection, and for 24 years did not approve the creation of a single new airline. Its natural growth stifled, the industry became static.

As the air-travel system became increasingly distorted by its inability to respond to changing needs, it became clear that consumers could be doing better on their own. What passengers paid for service bore no relation to the airlines' costs. Not that the airlines didn't sense the disparity; some of them of-



Airlines freed to set their own schedules created a new problem: congestion. The matter still looms as the greatest obstacle to the ultimate success of deregulation.

ferred bargain fares to fill empty seats in off-peak travel times, but the Board quickly quashed the practice, calling such promotions “discriminatory.” Continental Airlines once even offered to delete the customary meal service in return for \$10 discounts—and was ruled out of order. Meanwhile, long-haul passengers were indirectly subsidizing short-haul travelers. Aircraft operating costs make shorter hops relatively more costly. Coast-to-coast jaunts are more economical on a per-mile basis, but fares didn’t reflect that fact.

The combined effect of these ills overwhelmed the opponents of deregulation, and by 1985, only eight years after the Act passed, the route and rate rules, as well as the CAB, which had written them, had ceased to exist. Very few economic regulations remained, and these were transferred to the Department of Transportation. The framework of deregulation was now dismantled, and the airlines and their passengers were suddenly on their own.

At the heart of deregulation is the newly defined right of any

airline to enter another airline’s traditional turf. Entrepreneurs jumped into the fray. Chicago-based Midway Airlines became the first new airline to be created wholly as a result of the Act, and more would follow at a dizzying rate.

People Express has cut the widest swath, and some of its ideas are nothing short of revolutionary. People charges very low fares without any schedule or pre-purchase restrictions, and in return, passengers accept “no-frills” service in which they pay extra to check bags and buy inflight food. (While no-frills was not totally new—Southwest Airlines had initiated it within Texas in 1971, and Freddie Laker tried with his transatlantic airline—People took the idea and flew.) The airline is also partly employee-owned. Its workers accept lower salaries in trade for owning stock in the airline. With low operating costs to match its low fares, People Express climbed to ninth place in total traffic within just five years, and in the process turned discount air travel into a nationwide fact of life.

More new companies jumped in, many with ideas designed to set them apart from the other airlines: one banned smoking on all flights; others offered first-class service at coach prices. For the first time, passengers had a range of choices. Also for the first time, they voted “no” and walked away. The first business failure of an airline in the United States (aside from earlier mergers, which might be seen as failures) was allowed to happen, and many new firms fell by the wayside, victims of recession, insufficient capitalization, or unsuccessful fare wars with the big guys who had deeper pockets. But several upstarts have survived: America West, Jet America, Sunworld, Midway, and New York Air. And more, such as Presidential, are still cropping up. The impact upon older companies of the new entries’ lower costs, lower fares, new routes, and good service has far exceeded their numbers.

To put it bluntly, the new airlines have given the incumbents a boot in their collective derrières. Old-line managers have been forced to cut costs or face extinction. Some have succeeded and some haven’t. But you can’t argue with the numbers: there are now roughly 100 airlines, compared with 24 prior to deregulation. The number of monopoly routes—city pairs served by only one carrier—is down from nearly 4,000 in 1978 to about 3,600 today, according to the government’s General Accounting Office (GAO). The other side of that coin also looks better: the number of markets served by two or more competing airlines is up from 1,180 to 1,831. The traveling public confronts a new reality in which it can choose among airlines the way it can choose among fast-food restaurants.

Along with this freedom of choice has come a dramatic reduction in fares despite several years of inflation. About 85 percent of tickets sold today have been discounted in some way, compared with 30 percent under regulation. The average discount is up 20 percentage points, amounting to about 55 percent off the full price of a seat. The summary effect: fares fell an average of six percent between 1978 and 1984.

These figures from the GAO—its continuing assessment of deregulation provides the only objective data available—get loud applause from consumer groups. “In relative terms, people are better off today than they were five years ago,” says Cornish Hitchcock, legal director of the Aviation Consumer Action Project (a Ralph Nader organization).

The many technical objections to deregulation have faded,

one by one. Perhaps the most stubborn—lack of service to small cities—has solved itself as the airlines have re-equipped with smaller airplanes and gone after the considerable business that's there to be had in less-populated regions. The fact is that these smaller communities had received only grudging service under regulation; now they command attention as real markets—small markets, but real ones. There's no denying that some cities have lost their former large-jet service, and some have lost *all* service, even from smaller commuter airplanes that rushed in to fill the void when the jets left. But in the balance, many other communities have experienced an increase in flights and are even getting their first taste of bargain fares.

Major airlines are fighting for traffic they no longer get from former "feeder" airlines, such as Piedmont, which now have their own systems designed to retain passengers from point of origin to destination. All of a sudden, small is beautiful, and the major trunk carriers such as United and American have formed links with smaller airlines to restore the passenger

Christopher Springmann



If they can wend their way through intricate computer reservation systems, fliers can shop for the lowest fares.

feed that they lost. The resulting system is more economical, and the GAO reports that, "As a group, travelers to and from these (small) communities usually averaged lower fares" in 1984 than in 1978.

And fares could go lower still—to bargain-basement levels—if the recent acquisition by People Express of three feeder airlines is any indication of the future. The move squares People off against the major airlines and means it will have access to the passengers it needs to offer low fares to a growing number of small towns.

But the fundamental feel of air travel is also changing. Air

carriers once pampered the passenger and spoke of the "adventure of air travel" to people who dressed up to fly and looked forward to the inflight meals. However, with the introduction of the jumbo jet, or "widebody," in which flight attendants truly earn their pay when all the seats are full, there's not enough time for pampering anymore. Now the jumbo jet typically has one fewer engine—a nod to higher fuel prices—and more seats. The result is that operating economics open the door to true mass air travel. Perhaps the single best evidence of the economic success of deregulation has been the retreat of the bus companies, who simply can't compete against a \$99 coast-to-coast air fare.

Another part of the price that passengers now pay for reduced fares is less convenience. To shop for the lowest fare takes time, and the airlines don't make it easy. Many of the best deals carry cumbersome restrictions, and reservation phone lines are often taxed beyond capacity. Travel agents, formerly a storehouse of knowledge about air-travel value, can't keep up with the changes. The older airlines, in particular, are more likely to offer the temptation of low fares but with restrictions. You may have to buy a ticket up to 30 days in advance, travel on a weekend, or accept an intermediate stop, but the deals are still there.

But these restrictions won't last—in fact, they can't. Michael Derchin, a Wall Street airline analyst, says a two-tier fare will become permanent as the big airlines get their costs down to the newcomers' levels and compete head-to-head with a no-restriction set of fares, one price for peak air-travel times and another for off-peak periods.

The future will also be characterized by so-called "hub-and-spoke" operations that will increase the chances of at least one stop on any given flight. In place of large aircraft connecting cities on nonstop segments, the passenger will fly in smaller jets that connect at hub airports with another small jet to the final destination. Today, there are about two dozen such hubs, and more are coming.

Business travelers, who used to complain about loss of non-stop, direct flights, have been encouraged to embrace the hub-and-spoke system through the airlines' promotion of frequent-flier programs that reward participants with points toward free trips for each flight leg flown. The more legs, the more points the traveler earns.

Of course, the dust raised by deregulation has not all settled, and the system has one or two problems it still must resolve. The first of these is surely the way tickets are sold. United Airlines and American Airlines, by virtue of their enormous computer-based reservation systems, enjoy a certain control over ticket sales; TWA, Eastern, and Delta also have large systems, but the majority of computer terminals are linked to American and United. Critics say that the reservation computers provide an unfair advantage in ticket sales because the computers are biased toward sales on the host airline. Although travel agents are supposed to give the customer the best value, they may tend to favor the airline that provided their computer system. The airlines who laid out the money to build the computer systems argue that they have every right to take advantage of their investment. Although Congress held a series of hearings in 1985 to look into the matter, the government appears willing to allow the current practices to



Passengers aren't dressing up—or being pampered by airlines—in the new age of mass transit by air.

continue as part and parcel of a free marketplace. With several lawsuits pending on the issue, the matter is now more likely to be resolved in the courts than by legislation.

The clout of the major airlines may not be limited to their domination of computerized reservations systems, though. Some economists are now worried that a new trend toward consolidation of airline companies through mergers—perhaps a delayed effect of deregulation that just took a while to happen—could stifle competition and reverse the gains already made. According to this view, the initial phase of airline proliferation may be over, and now it's the upstarts' turn to hurt as the larger lines begin to flex their considerable muscle, entering markets in head-to-head competition with new airlines that lack the capital to compete in a long fare war. To date, though, no one has cited an inherently strong airline that failed or was absorbed, and it is therefore difficult to accuse large airlines of monopolistic practices, particularly while fares and service continue to please the traveling public.

In fact, the greatest single potential problem over the long term is airport congestion. The number of new companies and the new flights they added to airports, now supplemented by the entry of the larger airlines in a competitive counter-attack, has created a mess at many facilities that are simply over-taxed. And the hub-and-spoke practice bears the brunt of the blame for the burgeoning congestion.

At the hubs, the airlines may schedule as many as 35 flights to land within a 15-minute period—clearly impossible. Passengers are then supposed to change planes and depart again within another 15-minute period. But the air-traffic control

system was never designed to absorb that kind of demand, and runway capacity just won't absorb the load. The result has been delays, long lines of aircraft waiting to take off, and a growing resentment among passengers to whom printed schedules are meaningless. In response, the government has slapped limits on takeoffs and landings at a number of airports, including Washington National, New York's LaGuardia and Kennedy, and Chicago's O'Hare.

The congestion that arose out of deregulation is also often cited in concerns about air safety. But safety has not been sacrificed in trade for low fares. The Federal Aviation Administration regulates safety, and safety was never deregulated. It is irresponsible to try to link the two matters. The airlines' safety record is demonstrably satisfactory. According to the National Transportation Safety Board, scheduled air carriers in the United States had a fatal accident rate last year of .071 fatalities per 100,000 departures. The two worst accidents involved foreign carriers still operating under economic regulation in their respective countries. So where's the link be-

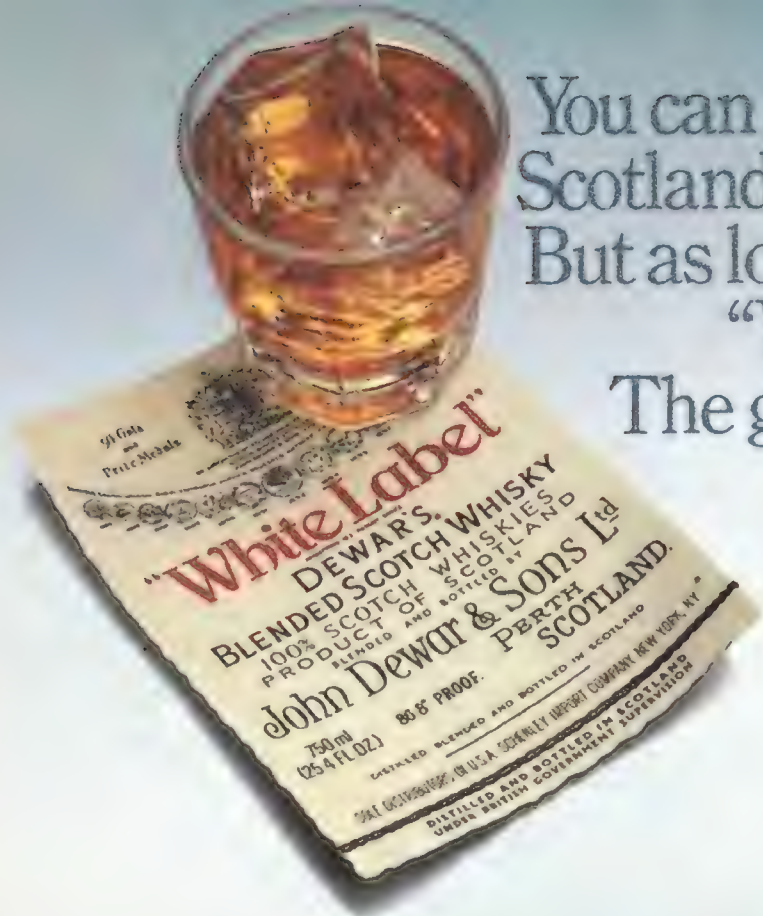
Brian Wolff



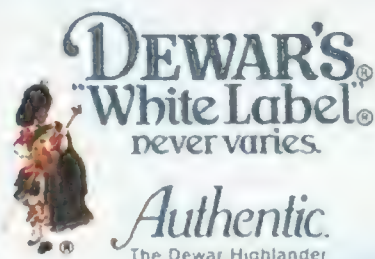
Some 100 airlines now vie for a traveler's business. Mergers could thin the ranks, but the industry will stay strong.

tween adequate safety and the continuance of regulation? (Incidentally, the U.S. rate of .071 fatalities in 1985 compares with .156 in 1973, .149 in 1974, and .100 in 1978.

It is long past time to declare regulation, re-regulation, or any other variation on the theme a dead issue. Regulation served its purpose during the period when the airlines were just emerging as a legitimate service industry, but when the airlines themselves outgrew the need for its oversight, it overstayed its welcome. The dramatic changes that have taken place so rapidly over the past eight years are only evidence of forces that were being artificially held from taking their desired effect, which is simply this: to configure an air-travel system adapted to the needs of the market it serves. ➔



You can drive the length of Inverlochlarig,
Scotland, in less time than it takes to blink.
But as local folk have known for centuries,
"Ye canna do it at rush hour."
The good things in life stay that way.







When Boats Flew

Seventy-five years ago, on the day the U.S. Navy ordered its first flying boat—which was also its first airplane of *any* kind—an era began. Naval aviation lasted, but the flying boats didn't.

By Richard Knott

The U.S. Navy P5M Marlin had been in the air for three hours when its radar operator suddenly stiffened at his display screen. Out of the hundreds of random echoes bouncing back from the surface of the ocean, one was just different enough to attract his trained eye. The difference marked a submarine's snorkel—the system of pipes that protrudes above the surface and through which a submerged sub draws its air supply. At about the same moment, someone aboard the submarine must have noticed the big flying boat boring in, because the target disappeared as the sub commenced a deep dive.

But the Marlin's crew had the submarine's general location fixed, and as the airplane arrived at the spot, its pilot cranked it into a sharp bank and began to fly in a tight circle. The crew dropped listening devices called sonobuoys—long, floating tubes containing sensitive microphones and small radio transmitters to link them to the airplane's receivers. The tactical coordinator, or "tacco," plotted their positions in the water while the sonobuoy operator listened for the sounds of the submarine's propellers. He could make out distant, receding sounds from one of the buoys—the sub had already broken out of the circle to the west.

The P5M followed and dispensed another ring of sonobuoys along the sub's presumed track, then circled 50 feet above the water while the operator listened again. Within moments, propeller noises could be heard growing louder from one of the sonobuoys, and at almost the same instant, the needle on an instrument called the Magnetic Anomaly Detector—or MAD—swung wildly as it picked up the disturbance in the Earth's magnetic field caused by the sub's metal hull directly under the airplane. "Madman!" its operator boomed over the intercom, and in response, a crew member tossed out a floating smoke flare to mark the spot.

The pilot turned sharply, nearly pivoting the big flying boat on one wing tip, and headed back straight toward the smoke.

The trusty PBY Catalina—a war canoe with glider wings—was the sight a downed pilot most wanted to see.



U.S. Navy

Glenn Curtiss laced up a four-engine giant called the NC. After that, flying boats never got any smaller.

No contact. The sub had eluded them—momentarily.

But on the next pass, a short distance from the smoke, there was another "Madman"—and another flare—and on the next, yet another contact. Now the "tacco" had the submarine's course and speed plotted, and the series of smoke flares described a line approximating the sub's track. The pilot lined up on the row of flares and began his attack. On his signal, the ordnance man tossed out a depth charge.

The airplane crew continued to track the submarine for some minutes until a spray of foam marked the surfacing submarine. The sub's radio crackled with the announcement that the "depth charge"—actually a training device armed only with a 12-gauge shotgun shell that would create an audible pop when it exploded—had been heard "close aboard." Had it been a real depth charge, the sub would have been finished. This practice session was over. But the sub's skipper had one request.

"Got an 'Orphan Annie' drop for us?" he asked. The comic strip's title had become code among sailors for newspapers.

"Affirmative," the P5M pilot answered. His ordnance man had filled an empty cardboard tube from one of the expended sonobuoys with current newspapers and taped it closed to keep its valuable contents dry. As they passed low over the sub, he tossed it out, and the crew below retrieved it. The crew above imagined the scramble below for a first look.

The flying boat and its crew would perform one more practice search before they were free to turn homeward to the welcome relief of solid ground after as many as six hours of grinding around in the turbulent air just above the waves. And

they knew that hunting for actual enemy submarines in combat would be a much more difficult proposition.

The P5M that they were flying on this mission in the 1950s was built by the Glenn L. Martin Company, and it had been designed and equipped for sub-hunting, ocean surveillance, and rescue. Its cockpit occupied a bulge atop the fuselage. Just below it was the electronics bay, complete with sensors that included the most powerful tactical radar to be put into any

U.S. Navy



U.S. Navy



airplane of the time. It could spot surprisingly small targets: the submarine's snorkel or a little shell of a sailboat in distress. It patrolled around-the-clock, using its wing-tip-mounted searchlight at night to complement the radar.

Each flying boat and crew conducted surveillance within an assigned area of responsibility, keeping watch for anything that moved on that particular patch of ocean. The flights were long, but the tedium was at least partly offset by rotating duties. Pilots switched off with navigators, who were usually trained pilots but had somewhat less experience. The four or five electronics technicians could switch-hit on the equipment, and the ordnance man usually doubled as a cook. Some of these airborne chefs produced excellent meals—including fresh bread—in the compact galley located below the electronics crew stations.

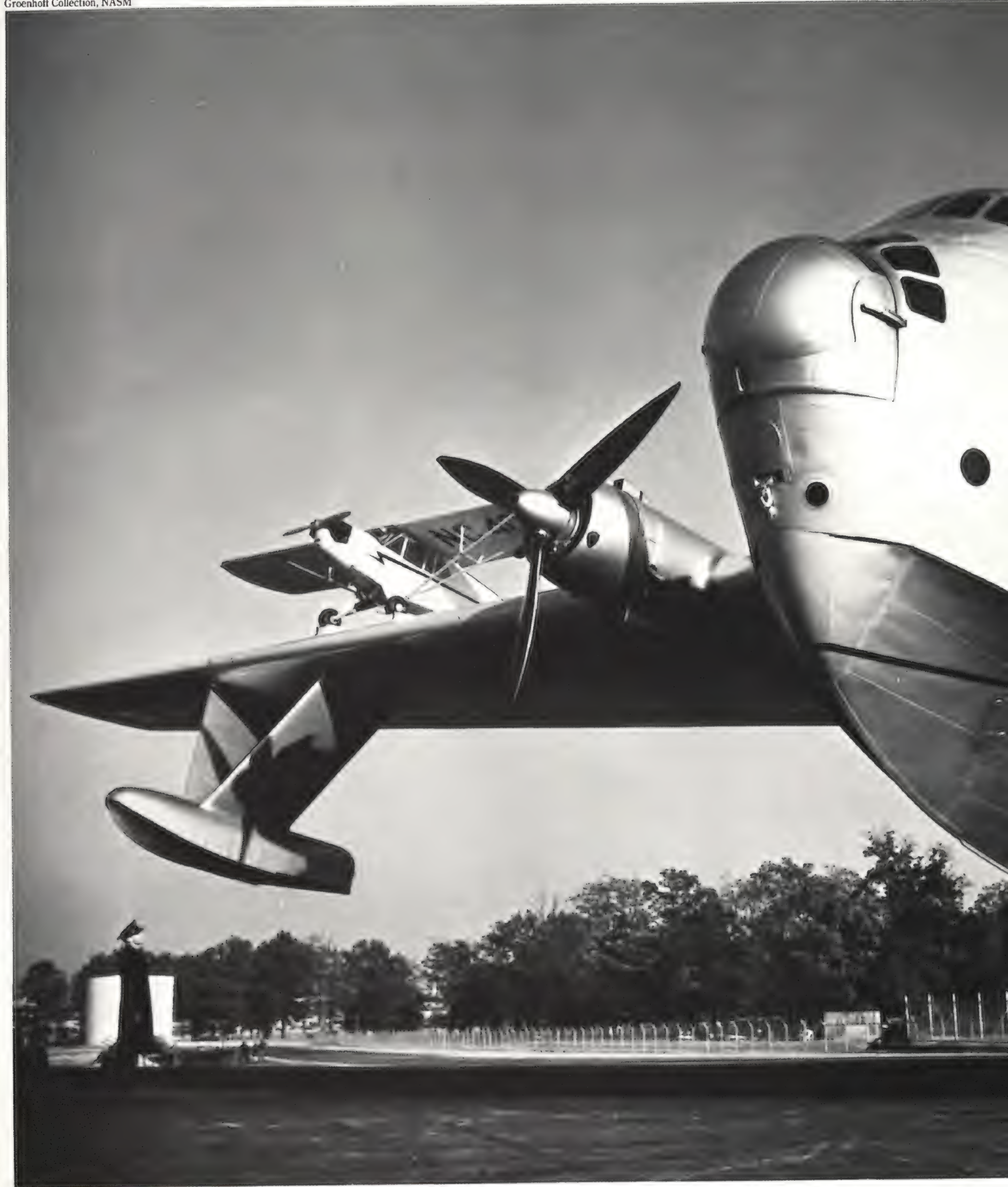
But operating an airplane from water imposed its penalties. To cope with the effects of the battering of the waves on takeoffs and landings, flying boats had to be built stronger—and heavier—than comparable landplanes. Internal equipment and instruments took a pounding that often shortened their

When this PBM Mariner lost an engine short of its destination, its pilot put it down on Willcox Lake. What made Willcox Lake exceptional was that it had no water. Never mind the details. The Navy dug a hole under the PBM, installed some wheels, and flew the "Mirage of Willcox Dry Lake" to a real body of water.



U.S. Navy

Jet-Assisted Takeoff—JATO—came in “bottles” that were strapped to the flanks of this PBM to help it take off in rough seas or with heavy loads.





A Piper Cub posed on a Mars wing to help publicize the immensity of the Navy's biggest flying boat.

life spans. And the corrosive salt water ate away at metal propeller blades and engine parts, reducing their service life compared to those of a landplane's.

In spite of their drawbacks, during this period in the 1950s the flying boat was still an essential part of the Navy's air arm. But the P5M and the skilled pilots who flew it were marking time to the end of an era. Despite such technical advances as its hull shape, which reduced the adverse effects of rough-water landings, the P5M would be the last flying boat to serve the Navy when it was finally retired in November 1967.

Still, the flying boat is not easily forgotten, for it is inextricably tied to the beginnings of naval aviation, the 75th anniversary of which is being celebrated this year.

As it happens, the very first airplane the Navy bought was capable of operating from the water. In 1911, Glenn Curtiss sold the service a seaplane designated the A-1. Curtiss later equipped the airplane with a set of wheels so that it could land on runways as well—a concept Curtiss named *Triad*, for its three spheres of operation: land, sea, and air. Later, at the Navy's request, he beefed up the hull to make it more like a boat—a “flying boat,” in fact. At that time, landings on aircraft carriers were mere experiments, and the concept of the carrier really would not become operational until the 1920s. Meanwhile, some of Curtiss's seaplanes saw action in the service of other nations in Europe during World War I, while those belonging to the U.S. Navy flew anti-submarine patrols on both sides of the Atlantic.

On one such patrol, a pair of flying boats from the Naval Air Station at Chatham, Massachusetts, battled a German U-boat that had surfaced to shell a tugboat and its barges. When the first pilot made his attack run, the bomb remained stuck in its rack. Both flying boats kept trying, and although the bombs finally dropped properly, they failed to detonate. The report of the action says that one pilot, driven to desperation, finally

U.S. Navy



Its crew escaped before this giant exploded. Christened the Marshall Mars, it had once hauled a record 301 passengers.



U.S. Navy

Marines had to move faster in the nuclear age, and this Convair R3Y Tradewind was the fastest flying boat yet.

flew low over the U-boat and tossed a wrench at its crew. Clearly, the concept needed work.

Curtiss also provided the Navy with the first of the large, long-range flying boats that would eventually typify the genre: the four-engine NC, designed to ferry itself across the Atlantic and save valuable time and shipboard cargo space. Although the war ended before it could show its stuff, the Navy dispatched three of these flying boats, dubbed "Nancies" by the press, on a highly publicized flight from Trepassey Bay, Newfoundland, to Europe via the Azores. Although two went down at sea, the third made it all the way, becoming the first airplane to cross the Atlantic Ocean. (Charles Lindbergh would make his historic flight several years later; to win the Orteig prize, he was required to fly between New York and Paris.)

By the opening salvo of World War II, the Navy's front-line patrol flying boat was the twin-engine Consolidated PBY Catalina. With its huge wing, the "Cat" was best at long flights at low speed, and after entering service in 1936, it soon established a reputation for reliability. Most of the PBY fleet was caught on the ground by enemy bombers at Pearl Harbor, and Cat crews experienced staggering losses in their retreat from the Philippines to Australia. A few of the airplanes were modified to drop bombs and torpedoes, despite their slow, plodding



U.S. Navy

The four-jet P6M Seamaster was the first flying boat that suffered no speed penalty due to its having a hull.

pace in the air, and PBYs carried off successful attacks at Midway, in the Aleutians, and in the Solomon Islands, where one Marine, thereafter known as "Mad Jack" Cram, launched a pair of torpedoes at an enemy assault force at Guadalcanal. Some PBYs were equipped with then-new search radar and painted black to conduct night operations; perhaps inevitably, they became known as the "Black Cats."

The PBY may be best remembered for its heroic rescues of downed pilots, in which it had no peer. Long before the helicopter took over that role, flying boats were the only way to pluck a hapless crew from a life raft in the middle of the ocean. One of the more spectacular of these rescues took place during February 1944, following a large bombing raid on enemy installations in the Pacific.

Lieutenant Nathan Gordon had been assigned to circle near some islands to pick up survivors from bombers downed by enemy gunners. Gordon, now an attorney in Morrilton, Arkansas, recalls the event vividly:

"There were heavy swells and very little wind, a combination that made open-sea landings and takeoffs particularly dangerous. It was difficult to judge the swells, and they could swamp the airplane if you made a mistake on landing.

"We made four rescues that day, and luck was with us. After each landing, we had to cut the engines to bring survivors aboard, all the while taking heavy fire from the beach. I was never absolutely sure whether the engines would start again, but they never failed us.

"We picked up nine men on three separate attempts and were headed home to New Guinea. About 20 or 30 miles from the town of Kaving, we heard still another call for help. Six men were down in a rubber raft close to an island. As I turned to go back there, I couldn't help but ask myself whether we hadn't already stretched our luck too far.

"We spotted the raft about 600 yards offshore, and I knew it was going to be a close one. My approach had to be made over

the beach, and the pickup would be directly under enemy guns. Should I risk the lives of the nine men we'd already saved in addition to those of my own crew? I looked down at the men in the water, and I knew I couldn't leave them there to die. The rest of us would have to take our chances.

"I put the Cat down just off the beach, taxied up to the raft and cut the engines while a lone B-25 bomber strafed the beach to hold down enemy fire. We pulled the men aboard, started the engines, and got out of there. In all, we rescued 15 airmen that day. I still hear from one fellow in the last group every Christmas."

Nathan Gordon received the Medal of Honor for that day's work, and after returning to civilian life, would become the lieutenant governor of Arkansas.

Although the PBY performed heroically, it soon became apparent that when it came to flying boats, bigger was better in the Navy's view. The Catalina was followed by the larger Martin PBM Mariner and the four-engine Consolidated PB2Y Coronado—bigger still. But at the war's end, the Navy introduced an airplane that still holds the record as the largest flying boat to enter operational service: the giant Martin PB2M Mars.

Only Howard Hughes's experimental H-4 Hercules, known popularly as the "Spruce Goose," was bigger than the Mars, but the "Goose" flew only once and then retired forever. The Mars began as a long-range patrol airplane, but its size and capacity got the Navy strategists to thinking, and its designation was soon changed from PB2M (for a patrol bomber), to JRM (for a cargo airplane). This four-engine behemoth set several weight-carrying and distance records before it was retired from service, and years later, two of them were still

The Convair Sea Dart floated on water—which made it a flying boat—and took off and landed on extended skis.

U.S. Navy





U.S. Navy

The flying boat's final combat missions were flown by P5M Marlins like this one being tended off Vietnam's coast.

operating as aerial tankers, putting out forest fires in western Canada.

At the end of World War II, the introduction of nuclear weapons began to change the Navy's thinking about tactics and strategy, but flying boats were still considered essential—if not more important than ever. To provide the U.S. Marines with a high-speed trip to the beach, the Navy developed the Convair R3Y Tradewind, a large flying boat with four turbo-prop engines and a nose that hinged upward so that loading ramps could be extended from the airplane to the beach. Now the Marines would arrive at more than 350 mph instead of at the lumbering pace of their old assault boats—and they wouldn't even get their feet wet!

In 1952, just a year after the comparatively conventional P5M Marlin entered service, a sleek new shape appeared in the waters off San Diego: the experimental Convair Sea Dart, a supersonic, delta-wing fighter that operated entirely from the water. It floated like a flying boat but operated from extended hydroskis during takeoff and landing to attain the higher speeds it needed. However, the Sea Dart suffered from severe vibration on takeoff, which eventually led to its cancellation after only five had been built and one had exploded.

There was one last great hope for the flying boat, and it rested in a remarkable four-engine jet: the Martin P6M Seamaster. No flying boat before or since was as technically advanced as the Seamaster. Former Martin test pilot George A. Rodney, the first person to fly it, said of the Seamaster: "The P6M was the first successful application of jet propulsion and high-speed aerodynamics to a seaplane. It was truly a Mach 1 aircraft, with no performance penalty for its ability to operate from water."

The Navy billed the Seamaster as a high-speed mine-laying patrol bomber, but that description may have been a smoke screen for a very different intended mission—that of a strate-

gic nuclear bomber. The P6M had a number of design features that were very advanced for its time, including a rotary bomb bay similar to the one on today's B-1B, and its performance was said to challenge the Air Force's best (which may have put it in political hot water from the start). But a flawed modification to its tail caused two to be lost in testing, and the Navy cancelled the program, ordering all P6Ms to be dismantled. That left the P5M Marlin to end its days as the last flying boat in service; it flew patrols in the southern delta of Vietnam and, later, in the Philippines before it was retired permanently.

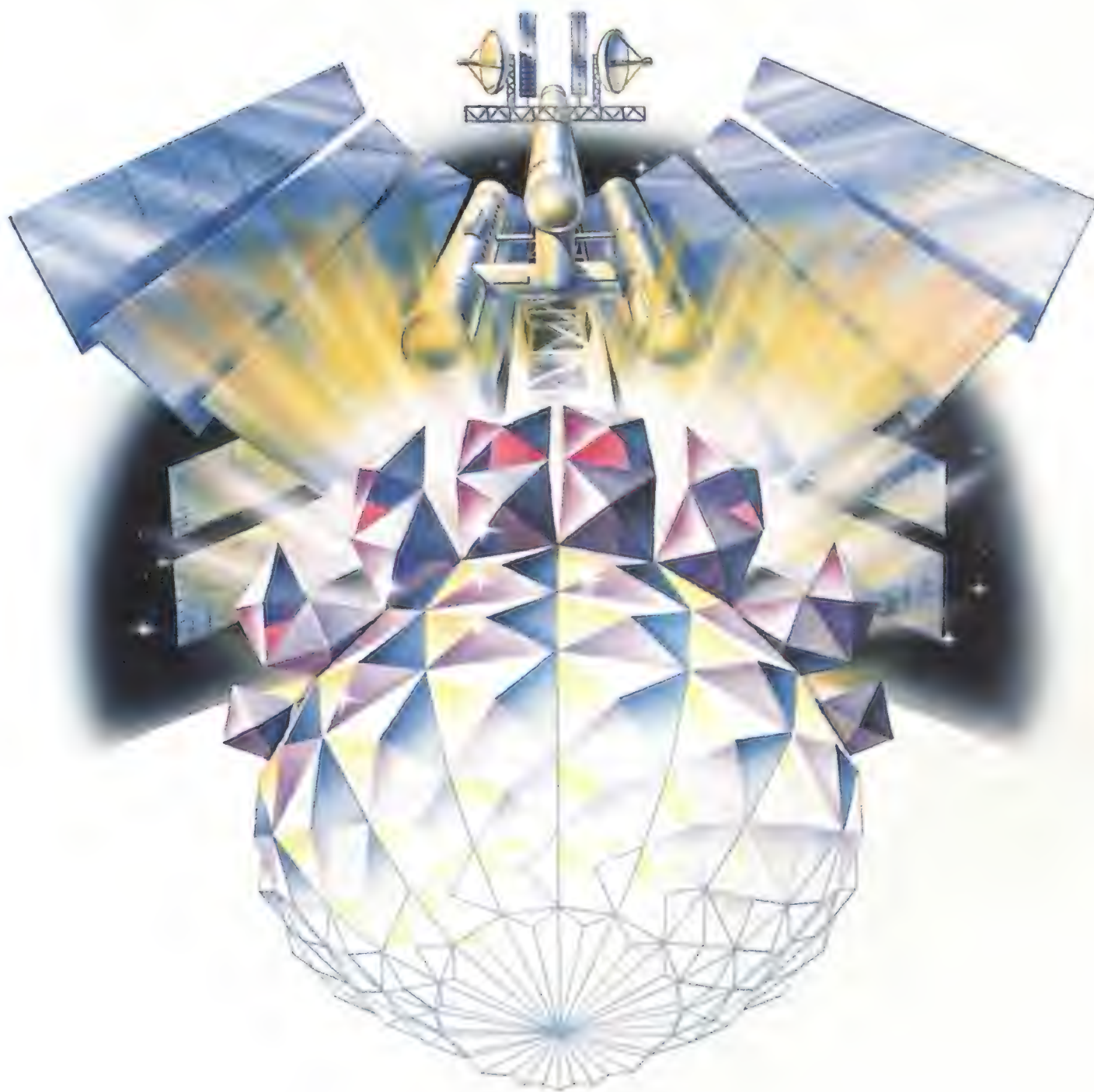
The era of the big boats had drawn to a close, and with it, a long tradition that combined the Navy's historic nautical know-how with aviation skills. Flying-boat pilots had to know both aeronautics and seamanship in order to manage the often conflicting forces of wind and water currents. The simple act of aiming for a buoy or a landing ramp could overwhelm even a veteran of both worlds. Taxiing in the open sea with only one engine working took special skills—flying boats had no wheel brakes to help in such situations. And on the water in strong winds, the airplane wanted more than anything to weather-cock—turn its nose into the wind as if it were already flying. When that happened, the pilot had to know how to "sail" backward, using the forces of engines and wind, to get where he wanted to be. But as cranky as the flying boats could be, there were memorable moments swinging at anchor on a quiet bay at dusk. These Navy airplanes and aircrews experienced the peace and beauty of the sea with an immediacy that no one who was a part of it can ever forget.

Although there are those who continue to keep the faith, it's doubtful that the flying boats will ever return in anything like their former numbers. Some development of the flying boat continues for civil applications in a number of countries, but the U.S. Navy has turned away from aircraft operations from water, seemingly forever. The flying boat's singular advantage—its ability to carry its runway with it—still argues in its favor, but at the moment, there seem to be runways enough for the land-based jet. In a world with a surface that's nearly 75 percent water, though, it is something to think about. —

'bal·əns

Balance

- A well-ordered integration of elements; e.g., combining the sales from diverse businesses into ten years of uninterrupted earnings growth.
- Stability produced by distribution of weight; e.g., planned diversification between commercial and government business.
- A harmony, one encouraging divisional entrepreneurship with strong financial support—like \$2.5 billion in capital expenditures over the last five years.



Ours is a strategic balance. Between commercial and government business. Between down-to-earth management and opportunities as limitless as space. This balance has been the key to our consistent growth, contributing to annual sales in excess of \$11 billion.

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Dollars from Heaven

There's no business
like space business.



By Phil Cohan

*Illustrations by
Bill Park*

From his beginnings, man has reached out to touch the stars. But in recent times his extended arm seems less like the symbol of human aspirations than the business end of a claw machine in a penny arcade.

Indeed, those cloud banks up there are looking increasingly like branches of Chase Manhattan. The vault of heaven seems to hold a vast reservoir of cash to be tapped by inspired investors. Outer space is in, dollarwise.

You can buy yourself a slice of the galactic pie at what some would consider a bargain-basement price. Perhaps you'd like to give your name to a star, or even name an entire constellation after your significant other? Step right up. It only takes a telephone call to John and Phyllis Mosele, proprietors of the International Star Registry.

The couple set up shop six years ago in Northfield, Illinois. They could have incorporated in Aurora or Orion, but Northfield was their home. And they're just plain folk—who have named more stars than Cecil B. DeMille ever did.

But don't think that life is all Milky Way and honey for those who manage such businesses. Critics challenge the legitimacy of the star-naming industry, because the bottom line is that a star registry has no official sanction to name the stars. Only the International Astronomical Union's Committee on Nomenclature can do that. Astronomers, convivial folk though they may be, aren't willing to name a twinkler after the person of your choice. They believe that a telescope makes a more appropriate gift—far better than a star, which should remain nameless except for its numerical moniker designated in official star catalogues.

But the star registries—there are now several—see themselves as filling a vital human need. And business is booming. The Moseles have given names to 175,000 stars. Their constellation of honorees includes Ronald and Nancy Reagan, Frank Sinatra, Johnny Carson, Fred Astaire, Liz Taylor, Alan Alda, Elvis Presley, John Lennon and Yoko Ono, Dolly Parton (two stars), Johnny Cash, Tom Selleck, and the Queen Mother of England.

Liberace, Burt Reynolds, and Joe Theismann are up there, too. Along with them are all 51 Heisman Trophy

winners and Barry Manilow's dog, Bagel. There's also a binary—two stars that revolve around each other, locked in mutual attraction—named after Prince Charles and Princess Diana.

And, yes, my name's there too. Inscribed in the Moseles' registry next to Virgo RA 12h57m34sd 18°17'. In a sense, that star belongs to me. And I have a certificate that attests to the relationship. A star by any other name is somebody else's problem. But mine is up there, exposed to the whole cosmos, blazingly dedicated to me by name.

I asked the Moseles what happens if my star, God forbid, burns out. They said they've never run into that problem, but if such a cataclysm occurs, they'd be glad to give my name to another star in the same constellation. They also said that none of the major insurance companies currently offers a policy against such a disaster. You just have to trust in luck and a benevolent cosmos. Understand, please, that my concern about the everlasting nature of my stellar stake isn't based on greed: neither property nor mineral rights belongs to the party whose name is borne by the star.

Although burnout apparently won't be a problem, I am worried about the company's bookkeeping. Both my name and my star's location are inscribed in the Moseles' book, which is registered with the copyright office of the Library of Congress (LC). But that book doesn't rest easily on the shelves, since there has been a history of wrangling between the registry and the library.

The Moseles, it seems, originally used the LC's name in their advertisements, violating the library's regulations and implying its approval of star registry activities. The LC issued a series of news releases declaring that it endorses neither the International Star Registry nor the business of naming stars. Newspapers printed the library's statements, and hundreds of people wrote letters to complain that they had paid good money in the belief that stars had been officially named after wives and brothers-in-law and the like. Some were pretty mad.

Attorneys for the International Star Registry and the Library of Congress got together in May 1985, whereupon the Moseles promised to stop using the



LC's name. Current ads say only that names will be compiled and registered with the library's copyright office. However, some library officials still greet even that statement with scowls.

For now, though, it's business as usual. Firm president Phyllis Mosele explains that there are 26 catalogues of numbered stars compiled by the International Astronomical Union. But only about 400,000 of them are in the Milky Way and visible through a low-power telescope. So don't delay your decision, or you may be forced to go to an observatory to see your star.

"Customers can request a star in almost any constellation," says Mrs. Mosele. There are a few limits to what can be named, though. The sun, for example, is simply too hot to handle. So are the 60 major stars. "We wouldn't want to rename them," she says. "That would be *too* presumptuous."

The story of the International Star Registry begins six years ago when Phyllis wanted to buy John an unusual birthday present. She found the perfect

gift in Canada, where the first star registry had been established by an entrepreneurial odd couple, an astronomer and an advertising executive. After naming a star for her husband, it wasn't long before the family obtained a franchise in the United States.

Many companies like to award a star—a real one—as recognition of outstanding performance on the job, say the Moseles. Recipients include the star-studded employee rolls of IBM, Nikon, Coca-Cola, Avon, Westinghouse, and Magnavox. And businesses aren't alone in valuing star-naming as a means to honor and status: the Mormon church bought 20 for its elders.

Anyone buying 50 stars at once gets them cut-rate, at a 10 percent discount,

and a purchase of 100 or more commands a 15 percent reduction.

While a star clearly makes an unusual birthday or wedding gift, another significant human milestone—death—can also serve to place your imprint on the heavens. The problem with most rites of passage is that—after undergoing the rites—you usually don't get to book passage and actually go anywhere. Well, all that's changed now.

In February 1985, the U.S. Department of Transportation approved a proposal for the first three launches of spacecraft by the private sector. The proposal was the product of an agreement between a group of undertakers and a company headed by former astronaut Donald K. "Deke" Slayton. His firm, Space Services, Incorporated (SSI) of Houston, Texas, plans to launch 15,000 human remains into space. So far, SSI is the only enterprise to receive such an approval. The launches are scheduled for early 1987.

The commercial interests of SSI ex-



tend beyond new wrinkles in funerary technology, of course. Slayton says he wants to carve a special niche for his firm in the business of space exploitation. SSI's Conestoga rockets will be used by businesses engaged in oil and mineral exploration, farm-crop monitoring, and land-use planning. Its first successful demonstration launch of a rocket, dubbed "Conestoga I," attained a suborbital altitude of 192 miles and traveled 320 miles. The first launch of cremains is expected to utilize a more advanced rocket in the Conestoga series. Almost all the firms that offer post-mortem travel plan to book space on Slayton's rockets.

One client of Space Services, Inc., the Celestis Group of Melbourne, Florida, plans to rocket its first urn into the heavens late next year or early 1988. Celestis, a group of morticians and engineers, offers a terrific deal: a no-frills, group-charter way to get there. It plans to launch a large canister containing the ashes of several thousand people, whose individual cremains will be contained in

a vessel resembling a tube of lipstick. The cost is \$3,900 per deceased, a bargain if you were a fun-loving type of person who liked crowds.

At Starbound, headquartered in Tyler, Texas, president Rusty Miller says he created the concept of "spacial post-cremation services." That's what he calls them, and he doesn't find the subject funny at all. Miller relates watching a space-shuttle launch one morning in early 1983 when, all of a sudden, he had this great idea. "It just hit me that people fear death," he says, "and maybe they'd feel differently if they looked up instead of down." Starbound was born that day.

A psychotherapist, Dr. Rafael Ross, operates Lad USA, a subsidiary of Lad,

Inc. International, in New York's World Trade Center. He is enthusiastic about eternal life in orbit. Space burial can be genuinely eternal, it is reckoned, because of the extreme cold in space. Lad USA wants to launch you or yours into any of three levels of near or deep space, with varying price tags.

In low-earth orbit, an urn of ashes—the cremains weigh four to five pounds—will circle the globe at an altitude of 150 miles. That will cost \$15,000. Or you might prefer a geostationary orbit 22,300 miles above the Earth. According to informed opinion, ashes should last forever at that altitude. The increased distance adds 25 percent to the cost. But the ultimate in deluxe services is a canister that follows the launch trajectory of the Pioneer 10 spacecraft—out of the solar system and beyond. That flight pattern boosts the cost to \$22,500, but that would buy one incredible ride.

Perhaps you don't warm to the idea of cremation. No problem. Rafael Ross will be pleased to ensheath you in a



"mummy" case, reminiscent of ancient Egypt. Prices on the launching of a dehydrated—but uncremated—body must be negotiated with Lad USA.

The normally voluble Ross won't talk much about official launch arrangements. But he does say that his firm already has 160 bookings and needs to hit 300 for a profitable launch.

The space-burial industry has produced more than its share of interesting ideas. One of those is the brainchild of Elliott Belland, 39-year-old carpenter and president of Stellar Interment in Silver Spring, Maryland. Belland proposes that you send your loved ones' remains to the sun in his canister. This way, he figures, they can return to Earth as radiant sunshine. The price for the solar journey is \$100 per gram of remains. He admits that he hasn't booked any participants yet, but he only needs 300,000 customers to fund a launch. The company plans to wage an ad campaign in Japan—the land of the Rising Sun—where it anticipates greater cultural receptivity and a better market.

Obviously, the major space entrepreneur today is Uncle Sam. The government lets huge contracts for construction of its satellites, vehicles, and laboratory equipment. The National Aeronautics and Space Administration had been renting room on its shuttles,

and plans to resume such activity after the current safety problems have been solved. And, of course, the government sells beads: microscopic beads, to be precise. The first made-in-space product is a latex bead ten micrometers in diameter, so tiny that 18,000 of them could dance on the head of a pin. The beads can't be produced here on earth because gravity would tug them out of shape. But in the weightlessness of space they emerge as perfectly rounded spheres. Scientists use them as micro-rulers for precision measurement of instruments and fine particles. You can buy the beads from the National Bureau of Standards, which will supply a vial containing some 30 million for \$386. That works out to a per-unit cost of \$.0000128—no doubt a bargain.

Some 350 companies plan to use the superclean vacuum of space for manu-

facturing and other operations. Such an environment—free of vibration, friction, and sound—will enable the creation of new and purer pharmaceuticals, better crystals, and thinner films for industrial use.

The Center for Space Policy, Inc., a consulting firm based in Cambridge, Massachusetts, estimates that space industries could annually produce \$18 to \$20 billion worth of products and services by the year 2000. Company spokesman Mark Oderman says this estimate is probably on the low side: it was revised downward in the aftermath of the loss of the space shuttle *Challenger*. Before then, his firm estimated revenues as high as \$51 billion, which, he adds, is still a possibility.

Private enterprise has thus found a way to prosper by heavenly alchemy, and space industries have founded businesses that are worth their throw-weight in publicity. But they require imagination, hard work, and chutzpah. You've got to have ingenuity to seize your heavenly rewards and still enjoy them here on earth.

These astropreneurs may gain fame and become fat cats in the process of taming space. But there are some 175,000 of us who won't be jealous. After all, we've already attained a lofty status of our own, for which we can thank our lucky stars. —



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WANG

Bioflight

In space, with no “up” or “down,” we’ll need ways to answer the question, “Where am I?”

Photographs by Louis Bencze

By Michael Rozek

Maybe you think you know what being in space will be like. Maybe you visualize the National Aeronautics and Space Administration’s photo of Bruce McCandless’s “walk” near the *Challenger* shuttle: man in high-tech suit, floating peacefully above Earth. Or, as someone who enjoyed *Star Wars*, you see space as romantic, even phantasmagorical. (If you like “The Jetsons,” you may even view it as suburban.)

Well, wake up and smell the coffee, America. For starters, space will of course be an experiment in weightlessness. And to those of us used to sitting down, life without gravity will be hair-raising. If we tried moving around in space, we’d become almost pathetically disoriented. In his book *How Do You Go to the Bathroom in Space?*, former astronaut William Pogue writes, “In weightlessness, there is no up or down insofar as your body feel is concerned. However, I did prefer things to look right-side-up.”

Even NASA, with all its resources, hasn’t ironed every wrinkle out of weightlessness yet. In fact, no scientist has yet figured out what it takes to ensure that human beings can function fully and naturally in weightless space.

Hmm . . . but maybe it won’t take a *scientist* to unravel the problem. Maybe, in the American spirit of invention, it can be tackled by a private citizen. An *amateur*, even.

Ray Bright would rather “fly” in space than in California and is helping others learn to cope with weightlessness.





Bright tests his "red, blue, and yellow axes" in a trampoline maneuver at California State University at Chico (above).



Even beginners at Chico's stunt-works learn quickly in Bright's classes—evidence that Bioflight is more than theory.

In fact . . . "three-dimensional reality?" . . . "body movement?" Sounds like a job for somebody from California.

It's another noisy afternoon in the echoing cavern of the main gym at California State University in Chico. On one side, hordes of males are sneaker-squeaking through some pickup basketball. On the other, a gymnastics coach is sternly watching a group of women who are hurdling vaulting horses. Over in one cramped corner is Ray Bright, a slight, energetic physical-education professor who is teaching 20 undergraduates how to come to terms with weightlessness.

"Okay, let's pretend that we've just gotten out of the space shuttle," Bright says. "We're floating in free space. Now, let's orient ourselves . . . where would 'up' be?"

"Up would be above our heads," chirps a student. "Down would be toward our feet."

"Where's 'back?' " asks Bright, with a hint of a smile.

"In back of us," pipe up a few more students, laughing as they wonder where this is heading.

"Okay," says Bright. "We turn 180 degrees, so now we're 'upside-down,' right?"

"Right . . .," murmur a few students, trying to keep up.

Bright's eyes gleam. This is the moment he's been waiting for. "*Wrong*," he intones. "Who's to say we weren't 'upside-down' before, and now, we're right-side-up?"

The class ponders this conundrum. Bright is asking them to visit, in their minds, a place they've never been before. Where there is no gravity, all movement is in three dimensions, and





earthbound dogmas like “left,” “right,” “up,” and “down” don’t mean a thing.

Now Bright is excited. “My point,” he says, “is that *you’re* the one who decides if you’re right-side-up or upside-down. Or which is your left, or your right.” He pauses to let this sink in.

Some of the students still look unsure. What Bright is saying sounds so simple, it seems almost pointless. Bright presses on: “Some of you might believe there’s no need to think about all this. Your orientation to living with gravity is so strong, you still don’t understand there won’t be an ‘up’ and ‘down’ referenced to Earth when you’re up in space. So, let’s try a little test.” At this, Bright asks one of his students to come up to the front of the class and tells him to raise his right arm above his head—to put it “in space.”

“Now, move it around in a circle, clockwise,” Bright instructs him. “Now move it down to chest level, continuing the clockwise motion.” The student does. Growing excited, Bright asks the class what direction the student’s hand is moving.

“Counterclockwise,” some students shout.

“You see,” says Bright, “how easily ‘clockwise’ can become ‘counterclockwise’ in free space? The words are just useless for navigational purposes, especially if you float away from your spaceship and flip around just once. Words wouldn’t even begin to tell you where you were.”

Bright moves in for the solution: “We’ve got to forget the standard directions we knew on earth. They’re meant for a two-dimensional world. We need to set up a new system of symbols that describes where we are in space and retrain our brains to use it. If our brains know what’s going on, how can they get confused?”

Ray Bright has come up with such a language, naturally, in which colors describe body movement in “three-space.” He calls it “Bioflight.”

By the fourth week of the semester, his students know it by heart: the body’s horizontal axis is “red,” its vertical axis is “blue,” its dorsal-ventral axis is “yellow.” (To visualize these,

As Bright maneuvers his “assistant” through space, students take a mental leap from earthbound thinking.

imagine colored swaths left to right across your chest, head to toe up and down, and through the torso from front to back.)

Bright wants to show that the Bioflight axes also function capably as a navigational language. He moves his class over to a nearby trampoline. They gather around it while he mounts a platform at one end. He’s poised to jump off and bounce—but first, a few words in Bioflight: “I’m going to rotate on red, translate on yellow, and slide on blue.” Decoded, this means he’s going to spring onto the trampoline and, once airborne, drop his left arm, duck, rotate forward on his back, and then land on the far side.

He jumps.

Then, the class follows, one by one. Ray Bright is a former competitive gymnast, which accounts for his fluency on the trampoline. But among his students, something miraculous is happening. Few of them are gymnasts, and many are not athletes. Some are obviously uncoordinated. But most are flying through the air—and with the greatest of ease—because they’re not trying to imitate some teacher’s gymnastic moves. They’re actually seeing the colors and axes, and they work! As a result, they’re gaining an inner sense of what weightless movement might be like.

“I could never do a front or a back flip before I took Ray’s course,” says Chico State senior Gene Passaniso. “Now, I can. I’m not scared in the air, because using the colors, I know where I am.”

“In the class,” says senior Scott Wilson, who’s taken it two years running, “we’re taught to actually *see* reference points in the air while we’re moving. I’d never done a back flip before, and with Ray I was close to doing one in just a few hours.”

Skeptics may scoff at a bunch of college kids seeing colors and doing back flips. But some people who ought to know



Bright's ultimate sphere is space; this sphere he uses to "retrain" humans for working and living aloft.

regard Bright and his ideas as significant.

Donald Means is director of the National Space Sciences Educational Foundation, a nonprofit group based in Corte Madera, California, that devises seminars for young people interested in space-related careers. At a meeting Means attended with some colleagues in Washington, D.C., he recalls, "Ray came over to talk to some people seated near us. He was carrying this small doll he uses to demonstrate the Bioflight axes and colors, and he started spinning it and moving it through the air. We sort of rolled our eyes at each other. You know, you run into some eccentric people at these gatherings. But as we started listening, his intensity and ability to communicate got through." Upshot: Bright has been invited to teach at the foundation's Space Sciences Academy Summer '86, at Stanford University.

And crucially, Bright's ideas have even found their way to one veteran of space flight, Byron Lichtenberg, who was a member of the crew of Spacelab 1 in 1983. Lichtenberg monitored some of the scientific experiments on board the spacecraft, including one on how the body reacts to motion sickness in space. He says, "If we build space stations, there's going to be an obvious need for people to fly quickly and efficiently between their various components. That's where I think Ray Bright's system could be helpful. I like what Ray is doing. He's teaching a way to disregard the visual world around you and set up your own internal orientation."

Lichtenberg adds that Bioflight might even be a link to a cure for the motion sickness that troubles some astronauts. "There'd be interest," he says, "in ways to help the brain preadapt to space travel before a person leaves for space. There will come a day when the average person will probably appreciate a tool—other than drugs, which can have

bad side effects—to help cope with the prospect of three days of nausea."

Defining "three-space" in colors may be a simple idea, but nobody ever thought of it before. "I don't think Ray knows how smart he really is," says Keith Lockwood, a mathematics teacher at Chico High School who is probably Bright's best friend. "He's spent so much time in the air and teaching about it that he's developed an awareness about movement in space that's alien to most of us. Einstein was able to *see* relativity. Sure, Ray is a college physical-education teacher. But people forget: Einstein was a government clerk."

Mention this to Bright, and he just smiles. "Growing up in La Crosse, Wisconsin, I was ten years younger than my brother," he explains. "He used to pick me up and toss me in the air like a ball. I feel that had something to do with my spatial orientation."

By the time he got to high school, Bright was doing backflips in the hallways between classes. "If I had an aptitude for anything," he says, "it was the intuitive ability to copy movement. I'd just break it down in my head and learn it." He went to college at the University of Wisconsin at La Crosse because it had a gymnastics team. By 1964, he was a letterman, but through it all, he was being pulled. Pulled up.

"I'd read about California in a gymnastics magazine," he says. "A lot of the top gymnasts in the country were out there. I felt if I really wanted to grow, I had to go there."

Bright did—and quickly wound up as coach of men's gymnastics at Chico. During his 18-year stint, the Chico State team won almost three-quarters of its meets and six conference championships, while turning out more than 40 NCAA All-American gymnasts.

During that same period, Bright began to explore a way of analyzing movement that would eventually lead to Bioflight. "Back in 1968 I started a gymnastic-theory class in our physical-education department," he recalls. "I quickly discovered that when I started diagramming basic moves on a blackboard,

I could begin to picture them as body positions, unfolding in space along three axes." Bright immediately started applying the same idea to his coaching. "The first guy on my team that I really tried it on wound up being an NCAA champion. It was then I knew I had the ability to get in and find the truth about movement, to analyze it down to the bone."

But it wasn't until 1979 that a third piece fell into place for Bright. He describes the experience as akin to satori, the Zen state of enlightenment. "I was looking at the famous NASA photo of the Earth floating in space. It'd been made into the front of a greeting card, and the word 'Home' was printed on the part of the photo that was just black space. Of course, the idea was that 'Home' meant Earth—but suddenly, I saw *space* as home, because in space, everything I'd been trying to do my whole life in terms of movement would be possible. In space, gymnastics wouldn't be gymnastics—it would be flight. Human flight. Ultimate flight. Bioflight."

By 1981, Bright was teaching Bioflight as an experimental physical-education course at Chico State. And instead of concerning himself only with helping students perfect their dismounts from parallel bars and pommel horses, Ray Bright started getting ready. To go home.

Until somebody will sell him a ticket for his first trip into space, Bright flies in Las Vegas. He takes field trips to Flyaways, a commercially operated "flying" chamber. The chamber contains a 22-foot-high vertical wind tunnel, into which air is blown upward at nearly 110 mph by a huge airplane propeller set safely below under a mesh floor. Customers at Flyaways can float prone, or "fly," atop the air for minutes at a time, then land on banks of cushions. It's like sky diving but without the parachute. And, though a film gives prospective fliers a thorough briefing before their first try, students who've visited Flyaways with Bright seem to handle

Flyaways, a vertical wind tunnel for people, offers would-be space travelers a Bioflight playpen.



the experience a lot better after being briefed in Bioflight.

"When the air would spin me around," says 20-year-old Sarah Leonard, a Chico State senior, "Bioflight gave me the ability to picture the *world* spinning instead of me. In fact, it was as if I could control the movements of the world—by making various Bioflight moves with my body."

"I've studied math to a pretty high level," observes Bill Hagen, a 26-year-old chemistry major, "so I already think in terms of coordinates and axes. But using Bioflight in the chamber, I felt as if all my math and physics training had taken on a visual dimension—that I was suddenly *seeing* the three-dimensional reality I've been studying all these years."

Ray Bright lives in a place he puckishly calls his "hangar." Scattered all over the living room floor are books about aerobatic aircraft, parachuting, space travel, and even a book by a World War II Japanese fighter pilot. "You know how the Japanese got to be such good aerobatic pilots during the war?" Bright asks. "They trained in gymnastics."

This night, Bright views a videotape of a local TV news feature done on Bioflight. Somehow, the station splices in an interview with a former astronaut, who's saying he doesn't see how "tumbling" could be a cure for motion sickness.

"That guy obviously doesn't know anything about what I'm doing," says Bright flatly, turning off the TV. "For one thing, the Russians try to develop the kinesthetic awareness of their cosmonauts by training them on trampolines. Why does a space program need Bioflight? Because if someone doesn't know how to move in space, they could start rotating and not be able to stop. Because even basic tasks need efficiency of movement. Because in space, time is going to be money. And right now, the only way people can maneuver in space without being tethered to a spacecraft is by using a machine—and that's totally cumbersome."

Byron Lichtenberg is encouraging Bright to write a Bioflight training program for astronauts and submit it to NASA's Space Biomedical Research Institute at the LBJ Space Center in Houston. Bright is taking up skydiving and saving money to buy an airplane. "I want to be the best flier on the planet," he says, and he's quite serious.

Of course, Bright also has to keep up with teaching his weekly racquetball classes at Chico State.

Which gets us back to the biggest objection anybody is likely to have to Ray Bright: "How can a gym teacher have anything to contribute to the space program?" Bright thinks he knows the answer: "It's an illusion to think advances in the space program come only from 'the space program.' 'The space program' is you and me—our country, our tax dollars. We can help make the future happen as much as anybody sitting in Washington or Houston. I don't think there's anyone who's put the kind of energy into a lifetime of studying movement that I have—not in this country. The next question is, how can the astronauts—and the average citizen—understand how to move in space without talking to somebody like me?"

And with that, Bright's eyes twinkle. The secret of Bioflight is unlocked, inside him, and ready for the taking. ➔

Students practice for the weightless life, floating in Flyaways' 110-mph big breeze.



Richard Tousey and His Beady-Eyed V-2s

In the early morning of February 26, 1946, Richard Tousey called together his small group of scientists in the Micron Waves Branch of the Naval Research Laboratory (NRL) in Anacostia, Maryland, so they could prepare for a nine o'clock meeting with the Rocket Sonde Research Section. Together, the two groups were trying to figure out how to photograph the sun's spectrum—the component parts of sunlight spread out in order of their wavelengths in the way that a prism produces a rainbow. Their plan was to use a spectrograph, essentially a light-sifting camera, housed in the nose cone of a captured German V-2 rocket that would fly to the top of the Earth's atmosphere.

Ernst Krause, head of the rocket sonde group, had convinced the NRL's brass that the research had to be done for important scientific and military reasons. (Krause's group had only recently been formed to use rockets to examine, or "sound," the atmosphere—hence use of the French *sonde*.) The Army had confiscated the V-2s at the end of World War II, and Krause (pronounced "*Krau-see*") had played a strong role in securing from the Army's Bureau of Ordnance the use of some of these valuable rockets by Navy scientists.

Krause had plans for a wide variety of experiments, and his group included experts in designing electronics and equipment for measuring cosmic rays as well as the temperature, pressure, and electrical charge of the upper atmosphere, or ionosphere. But he had no specialists in ultraviolet spectroscopy, which was among the most interesting fields of inquiry to be pursued with the rockets. That's where Richard Tousey and his group came in.

Two weeks earlier, Edward O. Hulburt, head of the NRL's Physical Optics Division, had asked Tousey to fill this scientific gap. Hulburt even offered him the use of a small spectrograph that had already proven itself on an expedition to the Arctic. But Tousey knew that the device's success didn't mean it would work on a vibrating, tumbling rocket. Moreover, Tousey strongly suspected that the spectrograph would not let the far-ultraviolet portion of the sun's spectrum through—which was what they wanted to study.

They needed to use a rocket to carry the spectrograph aloft because the Earth's atmosphere screens out the sun's ultraviolet rays, effectively blinding earthbound scientists to this crucial portion of the spectrum. No one really knew what would be found in the far-ultraviolet region, but there was speculation that it could answer many questions about how the sun works and how solar radiation influences radio reception, which was of particular interest to the military.

Tousey, an experienced physicist, knew that there was a

NASM



Just 40 years ago, Navy scientists
launching a German rocket
captured by the Army brought
back snapshots of the sun that
made history.

By David DeVorkin

*The first V-2s to reach White Sands were an awesome sight.
Scientists looking at them saw a unique opportunity.*



"spectral line" of hydrogen—a specific wavelength of light emitted by hydrogen in the sun—which sat in the far end of the ultraviolet spectrum and might be the very cause of the electrical activity in the ionosphere. He wanted to observe this "Lyman Alpha" line, measure its intensity, and find out what else was out there in this unknown spectral region. And Tousey was not alone. For example, James Van Allen's group at the Applied Physics Laboratory (APL), located in Silver Spring, Maryland, was among several research teams also planning spectrographic experiments.

The Army had decreed a schedule for launching its captured V-2 rockets, and while the various scientists were welcome to come along for the ride, the Army wasn't going to wait very long. The rocket parts hastily gathered in Germany had been exposed to corrosive salt water during their Atlantic crossing, and they now faced the wind and desert sands of the Tularosa Basin at White Sands, New Mexico. The parts were deteriorating rapidly.

Test launches were scheduled for late spring—only a few months off. "We all felt that we had to proceed with utmost haste in order to get some results from these V-2s," Tousey remembers, "because we didn't know when we'd ever get anything to match them." Van Allen agreed, saying, "Let's not muck around with writing reports. Let's go ahead and do the work." The race was on.

Once recruited by Hulburt, Tousey set about devising a new type of spectrograph. He delegated some of the job to his staff,

The V-2 Rocket

The V-2 rocket, the first long-range ballistic missile in the world, was developed late in World War II by Germany and used during the closing months of the war to bombard England (where over a thousand landed) and Belgium. It was 47 feet tall, with a maximum diameter of five and one-half feet. A V-2 weighed 14 tons fully loaded, of which 10 tons were fuel: alcohol and liquid oxygen. Its rocket engine developed 28 tons of thrust and could deliver a one-ton warhead 200 miles downrange in a matter of about five minutes.

The U.S. Army captured enough parts to construct about 100 V-2 rockets, and the parts were shipped to White Sands Proving Ground in late 1945. Due to inadequate storage facilities and corrosion of critical components during transfer across the Atlantic, far fewer than 100 V-2s survived to be tested by the Army and its contractor, General Electric. Starting in the spring of 1946, the best components were pieced together, but in place of the TNT that filled the German warheads, the payloads became scientific instruments to study the high atmosphere and near space.



NASM

Richard Tousey tried putting instruments inside nose cones, but finally moved them to the tail fins.

which at first numbered only two young physicists who had been anxious to leave the pressures of war behind them and embark on something fresh and professionally stimulating. Francis Johnson had worked in meteorology and weather forecasting during the war. William Baum, a graduate student in physics from the California Institute of Technology, had enlisted in the Navy and wound up at the NRL at the end of the war. Tousey reviewed the problem with them, and all three agreed on a new technical approach.

They knew the spectrograph couldn't use ordinary prisms, because prisms absorb the sought-after ultraviolet rays. Thus, they decided to use so-called "diffraction gratings," which could disperse sunlight into its spectrum, ultraviolet and all. The best diffraction gratings were based on a design that had been created in the 1880s by Henry Rowland at Johns Hopkins University. The gratings were deceptively simple. They consisted of a single concave surface that could collect light, spread it into a spectrum, and focus the spectrum onto photographic film, without need for any other optical elements.

But how to collect the sunlight and usher it into the spectrograph tucked away inside the rocket? The answer, Tousey decided, was to mount tiny see-through beads in small openings drilled in the nose cone. The beads would act as fish-eye

Forty years ago, on June 28, White Sands bustled as crews prepared for launch and scientists crossed their fingers.

lenses, gathering sunlight from a large portion of the sky just as a wide-angle camera lens covers more territory. This was a bold step, but Tousey knew he couldn't really *aim* the spectrograph from a tumbling rocket, and the wide-angle beads would be the best way to catch an occasional glimpse of the sun.

When Tousey explained his unconventional design to Krause during the nine o'clock meeting, Krause at first objected. Tousey wouldn't budge, however, even though he recognized that his system had some drawbacks, especially the fact that the beads might act as imperfect lenses and smear out the spectral lines. Finally, Krause agreed. The scientists also agreed that the Lyman Alpha hydrogen spectral line should be their primary target.

Tousey and his staff went back to refining their design. They searched out the best gratings, which turned out to be produced by John Strong at Johns Hopkins. While Francis Johnson studied different configurations for the optics and photographic film through March and April, Tousey and Baum contracted with a company in Cambridge, Massachusetts, to do the mechanical work. Walter Baird, the company's owner, promised to make the sophisticated scientific instruments in short order, and Tousey knew that he had to get things done soon or not at all.

Meanwhile, Van Allen's rival group had announced that it would have a spectrograph ready for a V-2 flight in early summer. Krause met this challenge, declaring that Tousey's device would be ready in early June.

Courtesy William A. Baum/Lowell Observatory

The design began to take shape quickly. The spectrograph had to be small enough to fit inside the rocket's warhead—where the TNT would have been—and Tousey tailored the beads and grating into an instrument that matched the conical shape. The V-2 was designed for war, not to land softly, and there was no time to design a complex ejection-and-parachute system to bring the spectrograph safely to earth. Instead, they decided to encase the all-important film in a thick cassette made of armor-piercing steel.

Making the special light-gathering beads proved to be no small problem. The beads were only two millimeters in diameter, about the size of shotgun pellets, and were made of brittle lithium fluoride crystals, chosen because the material doesn't absorb ultraviolet light. However, A.J. Devlin, head of the Naval Gun Factory Optical Shop, persisted. By the end of April, Johnson had a few beads to work with, and some gratings had come in from John Strong. Baum and Tousey made frequent trips to Baird's shop to check on progress.

Meanwhile, Krause's staff worried about how the spectrograph would actually fit into the V-2 warhead space, what types of mechanical and electrical connections would be needed, and how to design the telemetry equipment needed to radio back to earth data on how the instrument was operating. They were in charge of what the National Aeronautics and Space Administration would today call "systems integration"—making sure all the parts worked as well together as they did individually.



Science in a Spectrum

A bit of beveled glass in a kitchen window catches the morning sunlight and casts a beautiful rainbow of colors on the opposite wall. Raindrops in an afternoon shower snatch a ray of sunshine and spread it into a rainbow that arcs across the horizon. There is no question that when light is broken up into its visible color components, the results are lovely and often spectacular.

Light that has been spread out in this way is called a *spectrum*. It can occur anytime light passes through regions that differ in density, as from air to glass or air to water, in such a way that the light beam is bent. (Moreover, it works not only for visible light but also for wavelengths that are not visible to the human eye: the *infrared* and *ultraviolet*, which happen to contain some of the most interesting information in the spectrum.) If the geometry of the boundary between the two different media is just right, the white light is spread out so that all its component wavelengths can be seen in order, from the longer wavelengths at the red end to the shorter wavelengths at the blue end.

Spectroscopy, the study of the spectrum of an object in order to determine its physical and chemical nature, is one of the most important tools of modern science. Scientists have known for more than a century how to interpret a spectrum in order to study the nature of the object emitting the light as well as the environment through which the light passes. For example, the glowing, white-hot filament of an ordinary light bulb will produce a spectrum revealing the temperature of the filament.

If the glowing filament is surrounded by a cooler gas, the atoms in the gas will absorb certain wavelengths of light and thereby create dark gaps at intervals in the rainbow. These gaps, or *absorption lines*, reveal the composition of the gas. Using the laws derived from modern physics that describe how light interacts with atoms, scientists can determine the quantities of materials present in the surrounding gas, the pressure and temperature of the gas, and even whether the light source is moving toward or away from the measuring device.

Everything went quickly and smoothly—until, at Krause's urging, the Army agreed to test the durability of some film canisters similar to the cassettes Tousey planned to use. In the first test flight, on April 16, the rocket rose from the pad but began pitching and rolling wildly, never rising high enough to do any good. In the second test, on May 10, the rocket went up successfully but returned violently, gouging a hole in the desert that measured 25 feet deep and 30 feet across. The crater rapidly filled with water and the canisters were never found. In the third test, on May 29, only bits and pieces of the rocket were found at the crash site high in the Organ Mountains. Of the first three firings, one rocket failed and two disintegrated upon impact—not a good start.

German rocket scientists housed at nearby Fort Bliss were brought in to assess the situation. They advised that disintegration upon impact was to be expected. However, they suggested that if the rocket could be blown apart by explosives after *brennschluss*, or burnout, the pieces might fall more slowly to earth and survive. (While the recovery problem was troublesome for Tousey and his crew, it didn't make much difference to the cosmic-ray experimenters such as Krause and Van Allen. Their "cosmic-ray igloos"—stacks of geiger counters—could relay information by radio.) Even with this new plan in mind, however, some scientists still had serious doubts that Tousey's efforts would pay off.

The group's first spectrograph was scheduled for launch on June 27, and Baird delivered a device to the NRL on June 2. Johnson and Tousey quickly put it through vacuum tests and found that it worked well. But a mild sense of panic over the whole recovery issue set in, and hasty telegrams from NRL officials to Baird canceled and then reinstated his contract within a few days. The lab also considered both postponing the flight until recovery could be assured or redesigning the spectrograph as a photoelectric device that could radio back information about the solar spectrum while the rocket was still in flight. But by mid-June the decision was made to push ahead with the photographic instrument: Tousey's design worked and deserved a chance.

For the late June launch of their first V-2, Krause's staff prepared meteorological, ionospheric, and cosmic-ray experiments as well as the telemetry system and radio homing beacons. The warhead, made by the Naval Gun Factory, was shipped by air to White Sands, while Baum personally carried the little spectrograph by train. The entire payload weighed in at 2,310 pounds, with the warhead and the massive cosmic-ray device, which was shielded by lead, accounting for the bulk. The weight was just over the limit set earlier by the Army, and the NRL team had struggled to trim the payload to that size. But then the Army determined that the rocket was bottom-heavy and decided to add about 500 pounds of steel and cement to the warhead. The scientists could only shake their heads in dismay.

Baum got another shock when he saw his first V-2. Hardly sleek and smooth, as a space ship should be, it looked "as though [it] had been put together out of the scrap heap . . . like an automobile that had been in a number of accidents and had been straightened out again." But the rippled skin of the V-2 was a result of its construction: a shell-like structure connecting the thin skin to light ribs by numerous spot welds.

How Tousey's Spectrograph Worked

Paul Salmon

Every spectrograph has to provide a way for light to enter, a way to spread the light into a spectrum, and a way to record the spectrum for analysis. A prism or grating can disperse incoming light into a spectrum, which then must be focused so that the "fingerprints" of the solar rainbow might be detected by the naked eye, on film, or by using some form of electronic sensor.

Tousey's spectrograph used two small beads of lithium fluoride to admit sunlight. The beads were designed to gather a wide swath of sunlight, just as a wide-angle lens on a camera provides a wider view of its subject. This meant that the spectrograph, riding a wildly gyrating rocket, did not have to be precisely aimed at the sun to gather light.

The beads focused the sunlight into a point beam, which was reflected by small mirrors onto a concave *diffraction grating*, a piece of glass into which thousands of closely spaced parallel grooves have been etched. The grating spread the sunlight out into a spectrum, but the concave shape of the grating surface also focused the spectrum onto photographic film.

This ingenious and simple design, first developed at Johns Hopkins University in the 1880s by Henry Rowland, one of America's first great physicists, was perfectly suited to Tousey's ultraviolet studies. Everyone who obtained a spectrum of the sun from a rocket during the V-2 era used Rowland-type spectrographs, which were simple in design but amazingly good at their job.

Mirrors

Special film

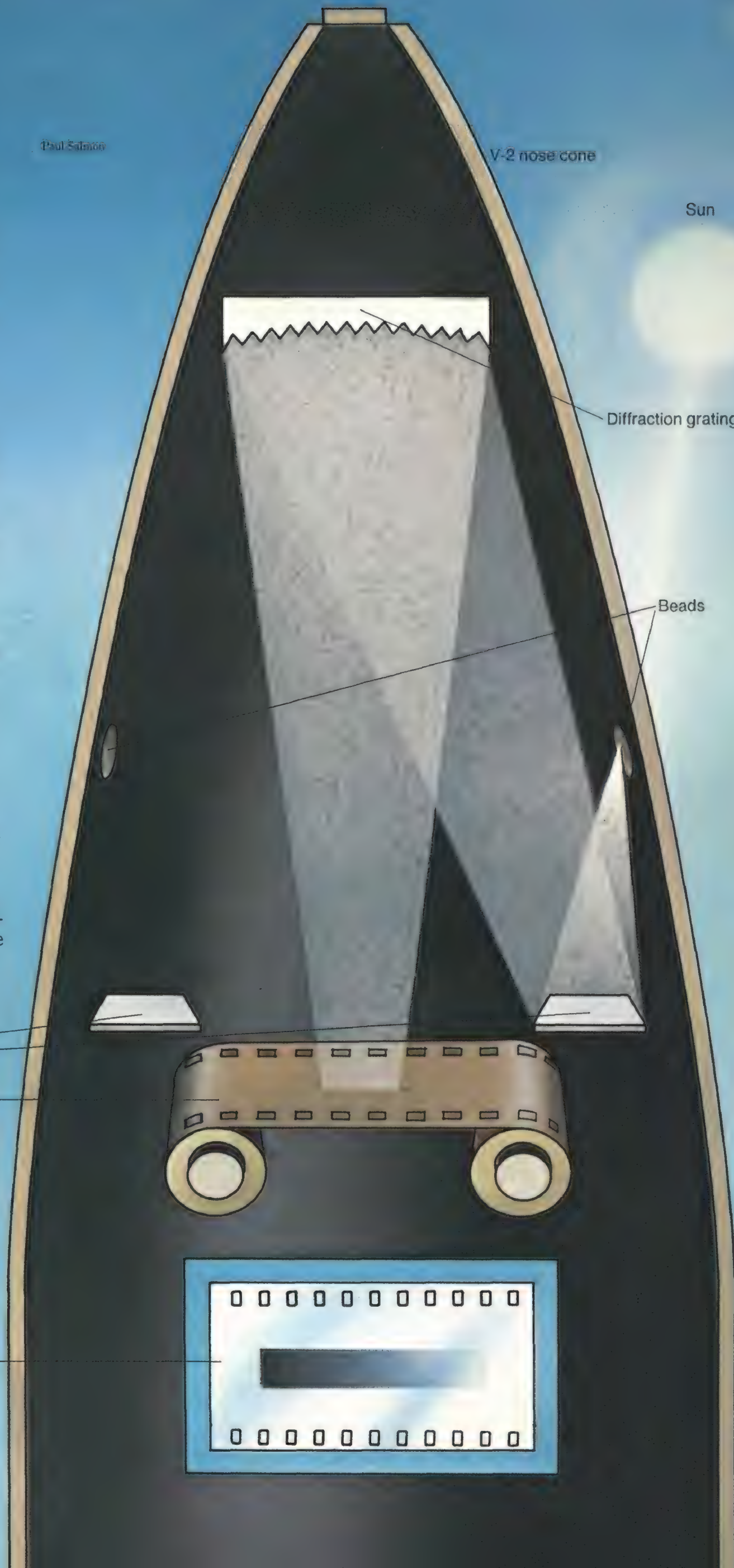
Image of spectrum on developed negative

V-2 nose cone

Sun

Diffraction grating

Beads





The man who wrangled the rockets from the Army for use by the Navy scientists, Ernst Krause, peers into the instrument-laden warhead. Francis Johnson, a meteorologist-turned-solar-scientist, paces anxiously.

The NRL team used the two weeks prior to launch to install and test the warhead and its instruments. The final checkout meant two days of labor in a hot hangar under the June desert sun—although the living quarters provided little relief anyway—and then evacuation of the launch area. During the checkout on June 27, something went wrong, and the flight was postponed.

At nine o'clock the next morning, the countdown began again for a 12:30 p.m. launch. The rocket fuel was loaded, and the team repeated its inspection drill. During the final moments before launch, the scientists could only wait and hope. "It was our job to chew our nails until we could locate the crater and see if we could find anything," Baum says. He was allowed to stay outside the blockhouse, behind a protective "boondock," so that he could photograph the launch. He felt the full impact of the rocket blast from only a few hundred yards distance. "There was a throbbing sound . . . that was impressive," he recalls. "It was . . . the kind of a throbbing you feel in your chest, as well as [hear] with the ears, even though

the rocket is by then fairly well up. You are very conscious of that, and then of the stillness that follows. Next you are trying to find out where the thing may have gone. There are tracking people . . . looking after that. Then the impact is finally located. They had planes [looking] around for the point of impact; and I remember we all got in a Jeep . . . Charlie Strain, I remember, drove our Jeep. A number of us went bouncing out across the desert in the Jeep to try to locate the crater."

Baum, Strain, and the Army quickly found the crater—but they weren't at all happy. The rocket had reached a height of 68 miles and the flight lasted 354 seconds. Data was gathered from the NRL's cosmic-ray counters and several other experiments, although the ionospheric telemetry system failed. After a radio signal from the V-2 told the controllers in the blockhouse that all of the photographic film had wound into the spectrograph's armored cassette, the controllers sent back a signal to trigger the explosive bolts and separate the warhead. The bolts obeyed, but the warhead refused and the rocket plummeted to earth. When the scientists reached the crater, they quickly realized that their spectrograph and its precious photographic payload, a 25-foot strip of film, lay buried under tons of rubble.

Discouraged, Baum nearly gave up on the spot. But the group's hope began to bloom again as the Army excavated the wreckage from the crater. Through June and early July, the G.I.s dug, but nothing came of it. In response, the APL team put development of its spectrograph on hold while everyone re-examined the recovery problem. Designs were begun anew for spectrographs that could radio back photoelectric data. But Tousey's faith remained unshaken; he was convinced that a photograph of the solar spectrum would be worth more than anything a photoelectric device, which would send back only limited information, could achieve.

And there still might be a way to bring back a spectrograph safely. During their stay at White Sands, some of the German rocket scientists offered the opinion that the NRL team needed to find an explosive technique that would sever the tail section from the rocket, so the tail would descend more slowly. By placing the spectrograph in one of the tail fins, the device might well survive. Indeed, on July 30 Van Allen's group tested this approach and the V-2's tail section landed very much intact. There was reason to hope.

During the rest of the summer, however, skeptics from the scientific world clucked as more launches failed. Only six of the first eleven V-2 flights succeeded. The next NRL spectrograph launch, scheduled for early October, would provide the clearest demonstration of success—or failure.

Tousey's team modified another of Baird's spectrographs to fit into a tail fin and put the device through its rigorous inspection. Meanwhile, the Army slipped the launch to October 10; the White Sands launch crew wanted more time to check out the fully instrumented V-2 before firing. Now chastened by the many failures, the crew felt that the Navy experimenters were getting in the way.

The twelfth V-2, the NRL's second exclusive flight, was the most ambitious to date. The rocket literally bristled with experiments and equipment. White Sands officials warned the NRL that it had to have everything in place by October 3, but then relaxed access to the rocket during the last week; the

The Atmosphere's Curtain

The Earth's atmosphere is absolutely necessary to sustain human life. Its oxygen is required for animal respiration, and a highly unstable form of oxygen called *ozone* shields the surface of the Earth from damaging solar radiation in the ultraviolet region of the spectrum. And beyond the ultraviolet, through the x-ray and gamma-ray regions, oxygen itself acts as an absorbing curtain.

Astronomers had long wondered what the sun looked like in these spectral regions, but the atmosphere's blocking effect kept all high-energy solar radiation from being sifted and sorted by the spectrographs in the astronomers' earthbound toolbox. They could show us all of the visible colors of the solar rainbow, from the far red through the blue and violet regions. But we couldn't see beyond the violet and near-ultraviolet.

Certain clues made astronomers feel that these hidden regions of the spectrum could reveal important information about what the sun was made of, how much energy it radiated into space, and how this radiation affected the Earth's upper atmosphere, or ionosphere. Only a rocket could carry astronomical eyes above the atmospheric ozone and oxygen. With rocket-borne spectrographs, Richard Tousey and his fellow experimenters could learn how ozone was distributed, how bright the ultraviolet portion of the sunlight was, and possibly what part of the solar spectrum was energizing the electrical activity in the ionosphere.

This last goal had a practical value as well: high-frequency radio, adopted by the U.S. Navy as its primary means of global communication, required the use of the ionosphere as a reflector that would allow radio signals to be skipped around the globe. If the ionosphere is disturbed, radio communications are almost impossible. The military services were most anxious to obtain information on what controlled the ionosphere so they could predict radio problems. Before World War II, most scientists believed that some form of high-energy radiation from the sun was the culprit, but they didn't agree on what part of the sun's energy spectrum was responsible. Rocket observations of high-energy solar radiation could solve the mystery: spectrographs and other sensors could be sent up beyond those regions where the energy was absorbed, to catch the incoming radiation and measure it, and provide just those answers that radio engineers required.

Tousey's first observations showed that the near-ultraviolet region of the spectrum lacked sufficient intensity to influence the Earth's ionosphere. By the early 1950s the solar rocketeers were pushing deeper into the ultraviolet and x-ray realms, and that's when they found what they were looking for: intense emission from solar flares—highly active eruptions of gas from the surface of the sun—and bursts of solar activity that had sufficient energy to disrupt the Earth's ionosphere.



The first V-2 shot made a crater deep enough to give the scientists pause. Their film would never survive this.

The crew stayed close to bunkers and blockhouse (rear) as launch time neared. Some V-2s strayed, others exploded.

Courtesy William A. Baum



Army and Navy crews were finding that they could work together after all. On October 8, the rocket was buttoned up and loaded onto its wheeled carrier, and the next day it was erected on the launch platform and tested. Work began well before sunrise on the day of the flight. Checkout and fueling went smoothly, and at 11:02 the rocket blasted into the crisp morning air.

The V-2 reached an altitude of 104 miles before controllers sent the signal for explosion. It worked beautifully: the pieces stayed aloft for nine to eleven minutes and fell to earth between 12 and 17 miles from the launch site. Almost every major part was found, including the spectrograph-laden tail fin, although it took a week of searching.

The spectrograph was recovered on October 16 and reached Tousey at the NRL two days later. His team removed the film cassette and took it to the Navy's Photographic Center for development under Tousey's direction. Now was certainly no time to make mistakes.

Tousey gingerly moved the film through a series of specially constructed troughs for brush development, "stop," and fixing baths. After what must have seemed like an eternity—but was probably not more than 15 minutes—the lights were turned on in the darkroom and Tousey gazed at the wet strip of developed film.

At first glance, what he saw was a number of gray streaks, none longer than an inch, at various intervals. Under a magnifying glass, however, the streaks became visible as tiny solar spectra, some clear and some fuzzy, and some longer than others. The streaks at the beginning of the roll were shorter, and they gradually lengthened as the frames advanced. Tousey didn't have to be told that the film had made a progressive recording, looking ever deeper into the ultraviolet solar spectrum as the rocket had climbed higher, gradually leaving the ozone screen of the atmosphere. He was seeing parts of the sun's spectrum that astronomers just a few years before could only dream about. Richard Tousey was the first human being to see such a sight, and in so doing, he established the future of the study of the sun from rockets.

According to Hulburt's and Krause's plan, and with continuing support from the military, Tousey and the handful of experimenters such as James Van Allen, Herbert Friedman, Homer Newell, and Marcus O'Day of the Air Force Cambridge Research Center, along with William Rense of the University of Colorado, flew a total of 20 tons of instruments—equal to a single space-shuttle payload—aboard 67 V-2 rockets.

They used up all the V-2s by 1952. But by that time the NRL had built the Viking rocket, and the APL had added the smaller Aerojet-developed Aerobee as a replacement. The Viking flew only about a dozen times, but the Aerobee, less expensive and more reliable, became the scientists' workhorse in the 1950s. It allowed many groups to delve deeper into the mysteries of solar ultraviolet radiation, reaching and surpassing Lyman Alpha and penetrating into the more distant x-ray region of the solar spectrum, where the answer to the sun's influence upon radio communications really lay. And later, through the organization of the International Geophysical Year, these groups came to form part of a world-wide fraternal network sharing the common experience of how to make a delicate experiment work on an unfriendly rocket. ➤



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Reaching Out, Reaching In

An American Indian artist connects man's exploration of space to the ancient truths of ceremony.



Dan Namingha, the first Native American to join NASA's art program, is equally at home with Hopi mythology and space-age technology.

By Pam Hait

*Photographs by
Susanne Page*

The slim, dark-haired artist waits easily on the margin of a world utterly new to him—or so you would think. Around him the crowd shifts and surges as each piece of each second is mechanically chewed and swallowed by the huge countdown clock.

Five. Four. Three. Abruptly, the voice coming over the public-address system is eclipsed by a staccato burst announcing ignition of Space Shuttle Mission 51-G. Dan Namingha is some 2,500 miles away from his ancient homeland, the remote Hopi Indian Reservation in northeastern Arizona. There, the artist's people live with a deeply religious tradition little changed in a millenium. Here, where the artist stands at Cape Canaveral, the twenty-first century beckons to Scientific Man. The bird rises, and two worlds merge.

Invited by the National Aeronautics and Space Administration to witness the June 1985 launch of the space shuttle *Discovery*, 36-year-old Namingha is the first Native American to join a NASA art team in the two decades that the agency has asked famous and not-so-famous artists to bear witness to man's exploration of space. The program—brainchild of then-administrator James Webb, who believed that the view of the artist might help link the space effort to the public's inner spirit—has been directed since 1976 by Robert Schulman.

Namingha is a member of two Indian tribes, the Hopi and the Tewa, and to the computerized world of space travel he brought an equally complex world of spirituality and ritual. The Hopi are considered—even by other tribes—to be the oldest of “the people,” having arrived in their chosen lands nearly a thousand years ago. They live in a few villages perched atop mesas that rise vertiginously out of the Painted Desert, and have eked a comfortable agricul-

tural existence from an unforgiving piece of the earth. Namingha is the great-great grandson of Nampeyo, a famous potter of the Tewa tribe, another pueblo-dwelling people of the arid southwest, and he was quick to appreciate his opportunity to build a bridge connecting ancient Indian culture with this newest American frontier.

“I had flown directly to Florida from the Hopi mesas where, the day before, I'd participated in a kachina ceremony,” Namingha says, recalling the launch. Kachinas are go-betweens to the rain spirits; during the growing season they appear in the Hopi villages, dancing in the hot, dusty plazas to encourage the rain spirits to come and make the corn grow in the deserts below.

“During a ceremony you become an intermediary between the earth and the spirit world, both taking and bringing back messages,” he says. “The marks of the sun were still on my body. And until liftoff I kept thinking of that ceremony, trying to reconcile that experience with being at Cape Canaveral the very next day. As I saw the liftoff, it all came together. ‘Here I am,’ I thought, ‘watching men go into space when I had just come from the place these men were going to.’”

Namingha relaxes in an aluminum lawn chair in front of his adobe studio, located outside Santa Fe, New Mexico. A traditional mud oven huddles next to the doorway—the only way to make good Tewa bread, he says. In the far distance, mesas and mountains, like jagged teeth, form the horizon. The sky is brilliant blue, torn only by an occasional airplane bound for Albuquerque.

“I really didn't know what to expect,” Namingha says about his trip. “I'd seen launches on television. But while I appreciated the space effort, on a spiritual level I questioned whether it was right



for man to intrude into space." Yet even before arriving at Cape Canaveral, he perceived reassuring parallels between Hopi-Tewa culture and the NASA program. For example, the art team's mission would take place over four days, and to the Hopi the number four is profoundly significant. Legend holds that the Hopi clans originally gathered at their home on the mesas after a long migration from four directions, and the number appears almost ubiquitously in tribal ritual. "For instance," Nomingha says, "when we fast, it is for four days."

Preparation for Hopi ceremonies is physically hard. "We come together to concentrate the experience so we can transform individual energy into a single, focused effort," he says. "We plant our thought patterns deeply so that they can be nourished and, in turn, nourish man. Our ceremonies involve all of us reaching out so we can then reach in."

Nomingha observes that the shuttle's design—resembling a bird, complete with nose, wings, and tail—also links it with Hopi belief. According to legend, the tribe emerged from a previous

Nomingha's painting "Emergence," which depicts Hopi gods mingling with an astronaut, was inspired by his attendance at a shuttle launch.



The arid landscape and dramatic topography of the mesas on which the Hopi have lived for centuries helped shape Namingha's artistic vision.

world into this one with the aid of a powerful bird. "Flight got people to this earth, and now we look to flight to get us to space, to another place," he says.

Indeed, eagles and certain hawks have a special meaning for the Hopi. Traditionally, tribal priests go forth in the spring to gather young birds, which are brought back to the villages and "baptized." The birds reside as family members, observing from rooftops that

the Hopi perform the proper ceremonies. In late summer the birds are "sent home" to encourage the rain spirits to come. Flight, embodied in these birds, is sacred to the Hopi, who were not surprised that the first words from the moon were: "The Eagle has landed."

Recapping the highlights of the events surrounding the launch, Namingha's eyes take on a faraway look. He describes his visit to the Vehi-



cle Assembly Building, the vast, cathedral-like structure where the shuttles and booster rockets are stored and assembled. Its rooftop, covered with acres of blindingly white protective material, provides a panoramic view of the land and sea surrounding Cape Canaveral. "Being up there was like being on top of a sand dune," he says.

That evening the art team went by bus to watch the finale of pre-launch

activities, "roll-out," when the supporting structure rolls away from the shuttle perched on the launch pad. It had rained all day and the storm was intensifying. The sky was a deep blue-black, with lightning flashing in electrifying arcs. "What got me was that lightning," Namingha says. "I saw it as a pictograph, as a snake." To the Hopi the snake is an important spiritual symbol representing lightning, which brings

rain and thus enables nature to nourish man. "It was very eerie, because I saw two things happening at once," he says. To a mind trained in Hopi tradition, such parallels are more than coincidence: symbols embody reality.

"The next morning, the morning of the launch, we got up early—four o'clock," he says. "As we were driving to the pad, I could see only outlines of things and it reminded me of going to an



Hawks, captured each spring by priests aided by youths, act as messengers to the Hopi spirits (above).

early-morning ceremony on the reservation. I had that same feeling of getting up and still being tired, but forcing myself to take part in the experience. Just as with a Hopi ceremony, there were so many people all waiting, all focusing on this one event, all concentrating their energies to make it happen.

"Our tribes are required to pray in the morning, because sunrise represents a new beginning. That morning, as the countdown continued, the sun came out and then went back behind a cloud. A patch of blue appeared above us and then there was an explosion. Smoke billowed from the pad. I heard a popping that kept gathering force, and I could feel the sound coming. I'd heard other people say it seemed like a heartbeat. All of a sudden, the sound came to me."

Namingha's voice, naturally quiet, hushes almost to a whisper. "It was gone in a matter of minutes. But the aftermath," he smiles, "*that* was another experience. All that smoke. Man was here on earth, and then—*bam*—

he's somewhere else." The artist peers skyward for a moment, then asks, "What does he leave behind? Smoke."

He pauses in his narrative, then muses, "There are so many themes here to explore. The launch. The shuttle trail. Smoke. Fire. Sound. If I had to paint a realistic painting, I'd go crazy."

He grins. "You know, the whole time I was there I kept thinking back to an experience my grandmother told me about, of the time that she first saw an airplane that landed in Hopi. She had my aunt as a baby on her back and ran out to this field to see this silver bird. Everybody wondered what it was. One man was so amazed by it that he touched the bird and then touched his hand to his body, as if to make some of that magic and strength flow into him."

Because each artist is required to donate an artwork to NASA, Namingha has an unusual opportunity to speak for his people. He is keenly aware that his paintings could add a previously unexplored dimension to the space-shuttle art collection. Yet he has never made an issue of being an "American Indian Artist," preferring to say, "I'm an artist who happens to be of this race."

Still, it is only natural that Namingha

Kachina dolls, prized possessions among Hopi children, are powerful symbols in tribal lore (right).

interprets his experience in terms familiar to him. He paints his feelings through ancient symbols, presenting them in his own distinctive abstract style. "My paintings are a personal vision of what I saw," he insists. "What I'm experiencing are my own feelings. I put myself in the place of that astronaut floating in free flight." It's the same as being in a tribal ceremony, he says, explaining that the participants transcend the symbols surrounding them. "You know that the symbols are all around you, but at the same time they become part of you."

In his launch-inspired painting "Emergence," there is no mistaking the majesty of a Namingha sun. "Where I come from the sun is a powerful symbol. It gives light and enables man to exist. And ultimately the sun lets him get where he is going in space. Without the sun, even the solar panels on satellites are useless," he observes. By combining the sun-spirit with a human experience, the artist fuses God and Man to probe where man is going with his technology.

The Twin War Gods of the Hopi are also prominent in the painting. These deities have a special place in Hopi thought: they hold the Earth in space and cause it to spin on its axis. One god watches over the land, the other over the water. Also depicted is the Humpback Flute Player, another significant Hopi spirit figure, who warms the land, causes it to flower, and spreads the joy of this beauty through his song.

By interweaving these symbols with an astronaut floating freely in space, Namingha seeks to fashion a timeless nexus between his own past and the future of all of us. He believes that everything comes full circle. He begins with a millenium of ritual and ceremony, reaches out through the present, and returns with a deeper spiritual understanding. Whether interpreting Hopi spirits, composing a pueblo village against a brilliant Arizona sky, or translating the hard-edged world of NASA into ancient symbols, Dan Namingha travels his cyclical path—reaching out to reach back in. —



Space: Speak to the Soul

I recently saw *The Dream Is Alive*, a large-screen IMAX film about the space-shuttle program. Against the backdrop of the *Challenger* explosion, it is a haunting documentary—you cannot escape the knowledge that some of the astronauts who are so vividly alive on the screen are now dead. Nonetheless, if you are ever near an IMAX theater, I highly recommend that you see this film. Because what comes shining through—beyond the fascination of the rockets and the other amazing technology of the shuttle, beyond the appealing curiosity of living in weightlessness—is the sheer, improbable beauty of Earth seen from space. It reminded me just how limited is our groundling view of the planet we live on and of the universe we live in. And it reminded me how profoundly exciting it is to explore the unknown.

The *Challenger* explosion has halted that exploration for now and raised questions about the shuttle program—about technical flaws, about how the National Aeronautics and Space Administration is managed, about what our priorities in space should really be. There is an urgency to these matters, since America's entire space program is on hold until some answers emerge.

In this growing debate about our national goals in space, I'd like to argue that exploration—directly by humans as well as indirectly by their machines—is the goal that counts most. It's not the only goal: commercial and military uses of space are important, too. Telecommunications satellites are big business. And what military buffs like to call the High Frontier is increasingly central to national defense, like it or not—spy satellites keep government and military leaders informed of actions that take place on the global stage, and communications and navigation satellites are becoming ever more integral parts of military operations. But somehow these uses of space don't speak to the soul, don't inspire our imagination.

NASA was originally—and still is at its core—a research and development agency; it was chartered to go exploring and to invent the ships to get us there. But recently it has been turned into a kind of cosmic bus

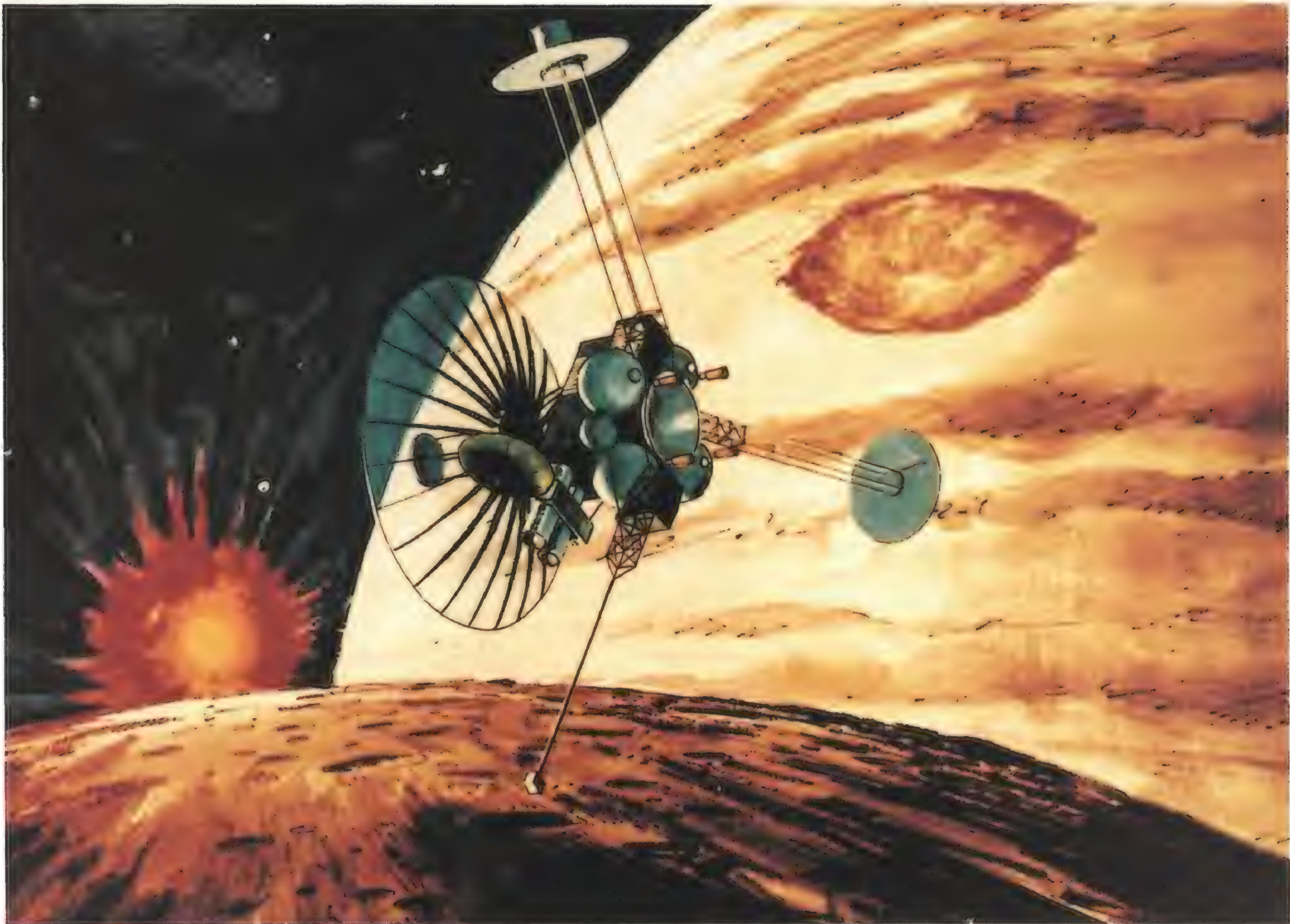
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Mars, potentially a second home for humanity, tugs at our collective wanderlust.

company, running satellite charters on an increasingly rigid schedule. And in its preoccupation with the space shuttle, much of the exploration has been squeezed out. The recent flybys of Comet Halley were by European, Soviet, and Japanese spacecraft, not American. If we want NASA to be more than a bus company, to reclaim its birthright in research and development, perhaps we need to separate the two functions. Let NASA develop and test the shuttle and other launch vehicles, but hand over routine operation to someone else: the Department of Defense, a more market-oriented Space Transportation Agency, or private industry.

Likewise the space program has a serious imbalance between manned and unmanned missions. At the moment, in fact, we have *no* unmanned launchers for spacefaring. The problem is not entirely of NASA's making. After the dramatic Apollo missions to the moon, the agency got little direction from presidents preoccupied with other matters. It won approval to build the shuttle, but at a high cost: the agency in effect had to promise a space-transportation system that would be reliable and cheap. Accordingly, all other launch vehicles were abandoned, all payloads were designed for the shuttle, and dozens of flights per year were scheduled.



Exploration, by humans and by probes such as this one portrayed near Jupiter, should be the heart of the U.S. space program.

Now, however, the government is changing its mind about putting all bets on the shuttle. The Department of Defense is already rushing to prepare new unmanned rockets for launching satellites needed for national defense; even so, they will probably not be ready for two or three years. NASA, under pressure, is also giving at least a slight nod to several commercial operations—private firms that want to build unmanned rockets capable of launching satellites—that it previously tried to discourage.

The shuttle will remain our primary heavy-lifting vehicle, and even some routine missions will need to be manned—witness in *The Dream Is Alive* the remarkable ability the astronauts have shown to retrieve and repair things in space. But NASA needs to develop its own unmanned launch system in addition to—or instead of—building a replacement for the *Challenger*, which at an estimated cost of \$3 billion would put still more squeeze on exploration activities.

Once NASA has built a more balanced transportation system capable of launching anything the military or commercial users can dream up—what then? President Reagan has committed to building a permanent

space station in the 1990s, but that only begs the question—a space station for what? To repair communications satellites? As a kind of orbiting Hilton for visiting VIPs? Or as a base for going back to the moon and Mars? The only enduring answer, and the one that keeps the taxpayer support coming, is exploration—testing the limits, going in person or vicariously where we have never gone before, finding out what is out there.

Consider the Hubble Space Telescope, now sitting in a Lockheed warehouse, waiting for passage to space. The largest and most sophisticated space observatory yet, it cannot be launched until the shuttle is flying again. But once above the Earth's atmosphere, the telescope will give us eyes that can see every nook and cranny of our solar system, that may be able to see planets thought to be circling nearby stars, and that can literally see nearly to the edge of the universe. Who knows what surprises await, what new visions of our universe and hence of ourselves?

Or consider a manned mission to Mars, proposed by prominent scientists and by the president's National Commission on Space

for the first decades of the twenty-first century. Mars, after all, is the most Earth-like planet in the solar system, a place that cosmic enthusiasts have seriously proposed “terraforming” by releasing into the atmosphere various life-supporting components now frozen in its polar caps and trapped in its soil. Mars is, potentially, a second home for humanity. And if the multi-billion-dollar cost and the ultimate three-year mission were to be a joint American-Soviet project, what more hopeful symbol for a new age, what better inspiration for the billions of us here at “home?”

Exploration is the only way for most of us to participate in the adventure of space. Until the day when a trip to space is an attainable experience, the excitement of new discoveries is the closest we can get. We are a species marked by intense curiosity and a migratory drive that has filled the Earth. It is not likely that our fascination with space, and specifically with exploration in space, is either shallow or a fad. But at present the priorities in our space program do not support the goal of exploration very strongly. Policymakers, please take note.

—Allen L. Hammond

Serengeti Rescue

Beryl Markham, who in 1936 became the first woman to conquer the Atlantic by air in a solo east-to-west flight, was born in England in 1902 but has lived in East Africa since age four. Raised by her father, a horse trainer, Markham took up aviation in her late 20s. She spent five years as a bush pilot, carrying mail, medicine, supplies, and passengers to remote areas of the Sudan, Tanganyika (now Tanzania), Kenya, and Rhodesia (now Zimbabwe and Zambia). She ended her aviation career with the 21½ hour North Atlantic flight and a bandaged eyebrow due to an emergency landing at Cape Breton Island, Nova Scotia, when her Percival Vega Gull ran out of gas. She eventually followed in her father's footsteps to train racehorses, and at 84 remains one of Kenya's most colorful residents.

West With The Night describes her life in and above Africa. The book garnered ecstatic reviews when published in 1942 by Houghton Mifflin, and was hailed as a forgotten masterpiece when republished in 1983 by North Point Press. Over the years, however, questions have arisen as to whether Markham was the sole author of West With The Night. Some who knew her think that her previously undemonstrated writing skills may have been considerably augmented by those of her third husband, Raoul Schumacher, an editor and ghost-writer from New York City. Though Markham once described herself as "illiterate," she has asserted that she "wrote the book out of boredom when I was living alone. [Schumacher] was a very nice chap [but] I didn't get along with him. He drank too much, and I got rid of him."

Regardless of the controversy, West With The Night caused Ernest Hemingway to effuse in 1942, "She has written so well, so marvelously well, that I was completely ashamed of myself as a writer . . . she can write rings around all of us . . . it is really a bloody wonderful book."

In the chapter excerpted below, "Why We Fly," Markham is searching the vast Serengeti Plain in an Avro Avian. She is looking for a fellow flier named Wood, who has been missing for two days.

If you were to fly over the Russian steppes in the dead of winter after snow had fallen, and you saw beneath you a date palm green as spring against the white of the land, you might carry on for 20 miles or so before the incongruity of a tropical tree rooted in ice struck against your sense of harmony and made you swing round on your course to

look again. You would find that the tree was not a date palm or, if it still persisted in being one, that insanity had claimed you for its own.

During the five or ten minutes I had watched the herd of game spread like a barbaric invasion across the plain, I had unconsciously observed, almost in their midst, a

Garbo and Hemingway in one—claimed the press of Markham.

Courtesy North Point Press





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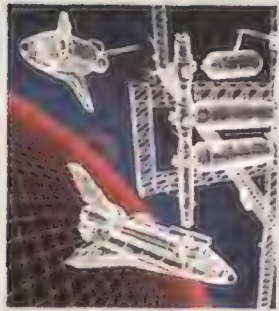
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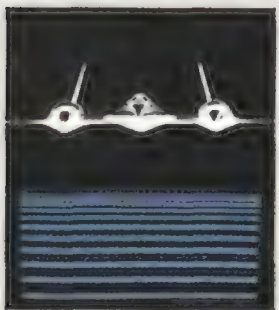
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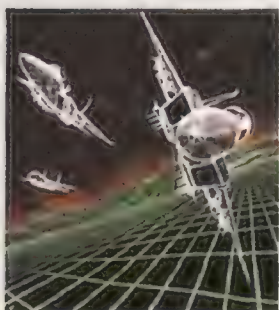
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(actual shirt photos)



Markham's aviation career ended with a solo transatlantic flight.

pool of water bright as a splinter from a glazier's table.

I knew that the country below, in spite of its drought-resistant grass, was dry during most of the year. I knew that whatever water holes one did find were opaque and brown, stirred by the feet of drinking game. But the water I saw was not brown; it was clear, and it received the sun and turned it back again in strong sharp gleams of light.

Like the date palm on the Russian steppes, this crystal pool in the arid rough-

ness of the Serengeti was not only incongruous, it was impossible. And yet, without the slightest hesitation, I flew over it and beyond it until it was gone from sight and from my thoughts.

There is no twilight in East Africa. Night tramps on the heels of Day with little gallantry and takes the place she lately held, in severe silence. Sounds of the things that live in the sun are quickly gone—and with them the sounds of roving aeroplanes, if their pilots have learned the lessons there

are to learn about night weather, distances that seem never to shrink, and the perfidy of landing fields that look like aerodromes by day, but vanish in darkness.

I watched shadows creep from the rocks and saw birds in black flocks homeward bound to the scattered bush, and I began to consider my own home and a hot bath and food. Hope always persists beyond reason, and it seemed futile to nurse any longer the expectation of finding Woody with so much of the afternoon gone. If he were not dead, he would of course light fires by night, but already my fuel was low, I had no emergency rations—and no sleep.

I had touched my starboard rudder, altering my course east for Nairobi, when the thought first struck me that the shining bit of water I had so calmly flown over was not water at all, but the silvered wings of a Klemm monoplane bright and motionless in the path of the slanting sun.

It was not really a thought, of course, nor even one of those blinding flashes of realization that come so providentially to the harried heroes of fiction. It was no more than a hunch. But where is there a pilot foolhardy enough to ignore his hunches? I am not one. I could never tell where inspiration begins and impulse leaves off. I suppose the answer is in the outcome. If your hunch proves a good one, you were inspired; if it proves bad, you are guilty of yielding to thoughtless impulse.

But before considering any of this, I had already reversed my direction, lost altitude, and opened the throttle again. It was a race with racing shadows, a friendly trial between the sun and me.

As I flew, my hunch became conviction. Nothing in the world, I thought, could have looked so much like reflecting water as the wings of Woody's plane. I remembered how bright those wings had been when last I saw them, freshly painted to shine like silver or stainless steel. Yet they were only of flimsy wood and cloth and hardened glue.

The deception had amused Woody. "All metal," he would say, jerking a thumb toward the Klemm; "all metal, except just the wings and fuselage and prop and little things like that. Everything else is metal—even the engine."

Even the engine!—as much of a joke to us as to the arrant winds of Equatorial Africa; a toy engine with bustling manner and frantic voice; an hysterical engine, guilty at last perhaps of what, in spite of Woody's jokes and our own, we all had feared.

Now almost certainly guilty, I thought, for there at last was what I hunted—not an incredible pool of water, but, unmistakable this time, the Klemm huddled to earth like a shot bird, not crushed, but lifeless and

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Wildebeest roamed the arid East African plains, where Markham scouted for elephants, safari game—and occasionally, a downed aircraft.

alone, beside it no fire, not even a stick with a fluttering rag.

I throttled down and banked the Avian in slow, descending circles.

I might have had a pious prayer for Woody on my lips at that moment, but I didn't have. I could only wonder if he had been hurt and taken into a *manyatta* [village] by some of the Masai Murani, or if, idiotically, he had wandered into the pathless country in search of water and food. I even damned him slightly, I think, because, as I glided to within 500 feet of the Klemm, I could see that it was unscathed.

There can be a strange confusion of emotions at such a moment. The sudden relief I felt in knowing that at least the craft had not been damaged was, at the same time, blended with a kind of angry disappointment at not finding Woody, perhaps hungry and thirsty, but anyhow alive beside it.

Rule one for forced landings ought to be,

"Don't give up the ship." Woody of all people should have known this—did know it, of course, but where was he?

Circling again, I saw that in spite of a few pig-holes and scattered rocks, a landing would be possible. About 30 yards from the Klemm there was a natural clearing blanketed with short, tawny grass. From the air I judged the length of the space to be roughly a hundred and fifty yards—not really long enough for a plane without brakes, but long enough with such head wind as there was to check her glide.

I throttled down, allowing just enough revs to prevent the ship from stalling at the slow speed required to land in so small a space. Flattening out and swinging the tail from side to side in order to get what limited vision I could at the ground below and directly ahead, I flew in gently and brought the Avian to earth in a surprisingly smooth run. I made a mental note at the time that

the take-off, especially if Woody were aboard, might be a good deal more difficult.

But there was no Woody.

I climbed out, got my dusty and dented water bottle from the locker, and walked over to the Klemm, motionless and still glittering in the late light. I stood in front of her wings and saw no sign of mishap, and heard nothing. There she rested, frail and feminine, against the rough, grey ground, her pretty wings unmarked, her propeller rakishly tilted, her cockpit empty.

There are all kinds of silences and each of them means a different thing. There is the silence that comes with morning in a forest, and this is different from the silence of a sleeping city. There is silence after a rainstorm, and before a rainstorm, and these are not the same. There is the silence of emptiness, the silence of fear, the silence of doubt. There is a certain silence that can emanate from a lifeless object as from a



chair lately used, or from a piano with old dust upon its keys, or from anything that has answered to the need of a man, for pleasure or for work. This kind of silence can speak. Its voice may be melancholy, but it is not always so; for the chair may have been left by a laughing child or the last notes of the piano may have been raucous and gay.

With the water bottle swinging from my hand on its leather strap, like an erratic pendulum, I walked around Woody's plane. Even with shadows flooding the earth like slow-moving water and the grass whispering under the half-spent breath of the wind, there was no feeling of gloom or disaster.

The silence that belonged to the slender little craft was, I thought, filled with malice—a silence holding the spirit of wanton mischief, like the quiet smile of a vain woman exultant over a petty and vicious triumph. I had expected little else of the

Klemm, frivolous and inconstant as she was, but I knew suddenly that Woody was not dead. It was not that kind of silence.

I found a path with the grass bent down and little stones scuffed from their hollows, and I followed it past some larger stones into a tangle of thorn trees. I shouted for Woody and got nothing but my own voice for an answer, but when I turned my head to shout again, I saw two boulders leaning together, and in their cleft were a pair of legs clothed in grimy work slacks and, beyond the legs, the rest of Woody, face down with his head in the crook of his arm.

I went over to where he was, unscrewed the cap of the water bottle and leaned down.

"It's Beryl," I called, and shook him harder. One of the legs moved and then the other. Life being hope, I got hold of his belt and tugged.

Woody began to back out of the cleft of the rocks with a motion irrelevantly remi-

niscient of the delectable crayfish of the South of France. He was mumbling, and I recalled that men dying of thirst are likely to mumble and that what they want is water. I poured a few drops on the back of his neck and got, for my pains, a startled grunt. It was followed by a few of those exquisite words common to the vocabularies of sailors, airplane pilots, and stevedores—and then abruptly Woody was sitting upright on the ground, his face skinny beneath a dirty beard, his lips cinder-dry and split, his eyes red-rimmed and sunk in his cheeks. He was a sick man and he was grinning.

"I resent being treated like a corpse," he said. "It's insulting. Is there anything to eat?"

Excerpted from *West With The Night*, copyright 1983 by Beryl Markham. Published by North Point Press and reprinted by arrangement.

Reviews(&)Previews

In Advance of the Landing: Folk Concepts of Outer Space. By Douglas Curran. Foreword by Tom Wolfe. Abbeville Press, 1985. 132 pp., photographs, \$16.95 (paperback).

The success of such movies as *E.T.: The Extraterrestrial* and *Close Encounters of the Third Kind* suggests that there is something irresistibly appealing about the possibility of non-Earthly life. We may not believe everything we hear about strange ships in the sky or meetings with alien creatures, but very few of us are willing to reject completely the possibility that they may exist. Douglas Curran's new book plays to that spark of wonderment by introducing us to groups and individuals dedicated to the pursuit of otherworldly life.

Curran is a professional photographer, so it is natural that photographs form the heart of his book. Much of the text takes the form of fact-filled, sometimes snappy commentaries on the photographs and the people in them. These commentaries show Curran to be an impressive hybrid of anthropologist, folklorist, and journalist.

Throughout a seven-year odyssey shaped by chance encounters and hearsay, Curran remained a neophyte space researcher, and this perspective is part of what makes his book so compelling.

Curran conceived the book's title long before he had any real interest in its subject matter. "The title, *In Advance of the Landing: Folk Concepts of Outer Space*, had come to me, full blown, in the middle of a dream one night in 1975," he writes. "I woke up, wrote the words down, and carried them with me in a notebook for two years without attaching any particular meaning to them." Only later, when he saw Charlie LaBranche's model rocket outside his general store in rural Quebec, did Curran recognize his intergalactic calling. "The rocket seemed to strain against its metal pylons, a totem attempting to leap away from the gravity of Earth to the realms of the gods. It was at one and the same time the quintessential product of western civilization, a daydream of technology, and a symbol of transcendence and freedom. It

Douglas Curran



Ruth Norman leads the Unarius Educational Foundation and looks forward to the Intergalactic Confederation's arrival.

was nostalgia for the future."

A stark photograph of LaBranche's rocket hints at the reasons for Curran's interest. There is indeed something absurdly compelling in the weather-worn rocket arching over the street. Here, too, we see a hint of Curran's photographic talents in the juxtaposition of smooth and rough textures, light and dark forms, and oblique and well-defined angles.

With some notable exceptions (the most striking of which is the stagey, gloriously hued cover photograph of a sculpture entitled "Flying Saucer"), most of the other photographs of places and things are rather prosaic. Without artistic pretension, these photographs portray subject matter in a folksy documentary style.

By contrast, Curran's images of people are captivating. They are curiously simple, unstylized portraits that are nonetheless memorable and very telling—and often very, very funny. Curran's subjects stand plainly and honestly, displaying their UFO wares: model spaceships, paintings, an "Interstellar Technical Research Billionium Falcon" (an old Chevy), and satellite tracking materials. These photographs provide a unique window on the world of space-watchers and UFOlogists.

Many of these people believe that only

beings from outer space are capable of rescuing Earth from an otherwise inevitable doom, Curran writes. Some claim that Jesus himself speaks through space creatures. These modern day "apostles" have taken it upon themselves to probe the skies for signs and spread the word to the ignorant.

"*In Advance of the Landing* shows how, in these confused and troubled times, humanity has integrated its most modern ideas—about technology and outer space—with its oldest religious ideas—about omniscient gods descending from the skies—and created a new mythology of hope and salvation," Curran explains.

This analysis is not a new one: more than 50 years ago, the pioneering Swiss psychoanalyst Carl G. Jung suggested that the round, crystalline spaceship was a mandalic symbol of unity and hope for salvation.

To his credit, Curran considers the spiritual and historical aspects of this new mythology separately from his documentation of the characters involved. He lets these people speak for themselves. We learn of the spiritual dimension of their interests, but we are allowed to see their day-to-day work—tracking the skies, holding conventions, building UFO landing pads—as the very pragmatic effort that it is.

In Advance of the Landing grew out of a dream and the chance discovery of a roadside rocket ship. It is a book to excite the imagination, to chuckle with, to pick up more than once. The reader joins Curran as he delves into a movement with which most of us are familiar only through vague references and check-out-counter magazines.

Some readers may be frustrated by the questions the book leaves unanswered: do UFO's exist? Are claims of extraterrestrial visits to be believed? Curran has not set out to answer these questions, but rather to document the conclusions reached by members of a fascinating subculture. *In Advance of the Landing* provides a close encounter of a very curious kind.

—Audrey Tashjian studied Folklore and Mythology at Harvard and Radcliffe Colleges, and has worked as an editor at Philadelphia magazine.

The Mars Project: Journeys Beyond the Cold War. By Senator Spark M. Matsunaga. Foreword by Arthur C. Clarke. Hill and Wang, 1986. 216 pp., \$17.95 (hardbound).

Senator Spark Matsunaga asks, "Would someone in the policy-making councils of government please look *up*?" The senator from Hawaii might better have asked whether someone would please *join him* in doing so. Matsunaga has already looked up—literally, to the skies, and figuratively, to the future—and he has seen a refreshing panorama of possibilities for international cooperation in space.

Matsunaga does not claim any special knowledge of space science or exploration, dating his interest in space only to 1980, when he first visited the observatory on Mauna Kea. But perhaps only someone with this outside perspective could suggest such radical, but nonetheless essentially plausible, changes in American space policy.

Since 1982, Matsunaga has introduced seven Congressional resolutions dealing with international, particularly American-Soviet, cooperation in space. One calls for dedicating 1992—a year significant to both major space powers, since it is the 500th anniversary of Columbus's discovery of America and the 75th anniversary of the Russian Revolution—as an International Space Year for "concerted worldwide commemorative recognition" of progress in space. Most of the other resolutions propose ways to foster American-Soviet cooperation in ventures ranging from space medicine and biological research to space rescue operations.

But his grandest plan calls for a joint manned mission to Mars. Repeatedly, the senator explains his motives: "Allowing space to become an arena of conflict without first exerting every effort to make it an arena of cooperation would amount to an abdication of governmental responsibility that would never be forgotten."

The book reprints Matsunaga's Congressional resolutions (which in themselves make fascinating reading) and describes the context—both political and, to some extent, personal—in which he proposed them.

The senator argues that the logic of day-to-day politics and the cold war have combined to create a "closed loop of insanity"—a hypothesis best supported by the seemingly unstoppable arms race. Too often, the senator writes, American foreign policy simply reacts against Soviet foreign policy. American space policy has frequently followed the same reactive pattern: the Russians launched Sputnik, which Americans interpreted as the beginning of a

"space race," so the U.S. inaugurated an intensive lunar-landing program. In this, the U.S. has unnecessarily handed the Soviets a tremendous advantage: the initiative.

Matsunaga suggests that asking the Soviets to join us in the trip to Mars would be a step toward taking the initiative ourselves. There is every indication that the Soviets would accept such an invitation. Over the years, the U.S. and the U.S.S.R. have developed oddly complementary space capabilities, "almost as if the two chief space powers . . . had unconsciously divided up the best initial opportunities," Matsunaga says. The U.S. has better planetary orbiters, while the Soviets have better planetary landers, for example. Cooperation on a major interplanetary expedition would thus serve the interests of both nations.

Such a massive project would require long-term planning on a scale to which American politicians are unaccustomed—but the benefits would be enormous. First and foremost, cooperation requires the open exchange of information—an inherently democratizing process, in Matsunaga's view—and this exchange would be just as beneficial to us as it would be to the Soviets. The threat of technology transfer would be minimal, since most of the technology employed in the types of missions Matsunaga envisions is already public knowledge, and any new technology could be adequately protected. Cooperation would prevent us from being "Sputniked" again—and it is worth noting that the Soviets have made no secret of their desire to send a manned mission to Mars. The 75th anniversary of the October Revolution would be a prime target date for a Soviet space spectacular. And finally, Matsunaga posits, cooperation would establish a precedent for peaceful cooperation and democracy in space that might prove decisive in shaping the laws by which space ultimately will be governed.

Matsunaga opposes the militarization of space. He is an outspoken and persuasive critic of Star Wars. "Even if the Strategic Defense Initiative works to perfection and Soviet ICBMs are rendered 'impotent,'" Matsunaga writes, "the disease [of arms build-up] will continue to spread: the Soviets will simply shift to other strategies of nuclear deployment even more mad than MAD [Mutually Assured Destruction]. . . . An 'impotent' nuclear-armed Soviet Union would present us with problems that would make Middle East terrorism seem like a playful lark."

This is not to say that he sees no role for the military in space: to the contrary, Matsunaga reminds us that "America's first and still most glorious expedition of explora-

tion was led by two Army officers—Lewis and Clark." Drawing on that tradition, the senator proposes "a space exploration policy that aligns the Air Force with NASA. NASA would handle conception and design of all space missions, and the operation of unmanned missions. To the Air Force would fall operational direction of manned space exploration that would be carried out openly and in cooperation with other spacefaring nations."

There is much more to this book: a discussion of American strengths and weaknesses in the global high-tech marketplace, for example, and speculation on the role of the frontier in shaping American history and national character.

The senator's writing is not elegant—the jumps between personal autobiography, political memoir, and policy analysis are sometimes awkward—but Matsunaga is eloquent in his vision of hope for the future. *The Mars Project* could prove to be a tremendously important book, and it certainly should be read by anyone with an interest in America's space program. —Katie Janssen

Augustine's Laws. By Norman R. Augustine. Viking, 1986. 380 pp., B&W illus., \$18.95 (hardbound).

In the current bull market for books by, for, and about businessmen, *Augustine's Laws* outperforms just about every other recent title on the shelves. Originally published in 1983 by the American Institute of Aeronautics and Astronautics, Inc., for an audience of aerospace managers, Norman R. Augustine's book has been revised and expanded for a broader audience and was reissued this spring by Viking. Although it undoubtedly will not sell as many copies as the runaway best-seller *Iacocca*, it's sure to join the blue-chip ranks of such classics as *Parkinson's Law* and *The Peter Principle*.

Augustine is the president and chief operating officer of Martin Marietta Corporation. The fact that his ascendancy within the company occurred primarily during the time that Martin Marietta was under takeover attack from the Bendix Corporation speaks well for his understanding of organizations, and the people who manage them, under duress. His background gave him plenty of opportunities to develop this understanding: he accepted a position in the Pentagon just as the Vietnam conflict began, and he left Douglas Aircraft just prior to its acquisition by McDonnell Aircraft. "Scar tissue," he allows, "is probably a valuable asset in business, albeit not always pleasantly acquired."


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Business Management—and Offers Solutions," the book is divided into 52 chapters—each summarized by a "Law"—one for each week of the year. One chapter demonstrates that there's absolutely no correlation between high salaries and employee motivation; another describes the inverse proportion between a country's number of lawyers and its productivity. Augustine's delightful, droll wit makes his insights all the more compelling: his laws range from "Hungry dogs hunt best; a hungrier dog hunts even better" to "Bulls do not win bull fights; people do. People do not win people fights; lawyers do."

Although many of the book's case studies are based on the author's experiences in the aerospace industry (violating, Augustine says, the custom among Washington writers of writing on topics of which they have no knowledge), the book should be required reading for any business school student—and for just about anybody who wants to get things done in a world of self-defeating organizational behavior. But unlike most required reading, this book is downright fun.

I can't think of a better way to uncoil, after another frustrating day of unproductive office meetings monopolized by those with the least to say, than to pick up *Augustine's Laws* and read such gems of wisdom as Law Number XLVIII: "The more time you spend talking about what you have been doing, the less time you have to do what you have been talking about. Eventually, you spend more and more time talking about less and less until finally you spend all your time talking about nothing."

—Walter Nicklin is a publishing consultant based in Arlington, Virginia.

Gray Eagles. By Duane Unkefer. Beech Tree Books/William Morrow, 1986. 467 pp., \$17.95 (hardbound).

The year is 1976. Colonel Roger Lowen and four other pilots are flying their P-51 Mustangs to an air show in California. Suddenly, eight German Messerschmitt 109s streak across their flight path in an attack formation. Lowen, an aging WWII ace, fights down panic. "What do you think we have here?" he asks a fellow Mustang pilot. "Twilight Zone," comes the reply. For Lowen, the sight of the German planes reawakens war memories, the "cold fear of being jumped by enemy fighters."

Lowen has good reason to be worried. The German flyers—all former Luftwaffe aces—are led by two pilots who are out to get him. Thirty-one years earlier, at the close of WWII, Lowen strafed their crippled planes on a German airfield, killing one of

their buddies. Now the survivors are out for a rematch in the skies over America.

It's an unlikely premise, but one that author Duane Unkefer manages to get off the ground. He sets much of the first half of the book at a hidden airstrip in Arizona, where the "76 Staffel" trains for three missions that culminate in a showdown with Lowen. Unkefer takes obvious delight in describing the restored, battle-ready Messerschmitts. He's even made improvements: the planes now have retractable Galland hoods for open-cockpit flying, padded fiberglass seats instead of steel ones, and improved instrumentation and weaponry. A flourish completes the modifications: Velcro tabs on the German uniforms.

The story loses focus when it drifts to peripheral characters, such as Marta, the German hostess who disrobes every few pages, and Webb, a young Air Force investigative officer for whom "get down" and "outstanding" are meaningful phrases. More satisfying are the "gray eagles" themselves, the German and American pilots, whom Unkefer portrays as the last of a noble breed. They, like their airplanes, are restored and improved by the prospect of going into battle.

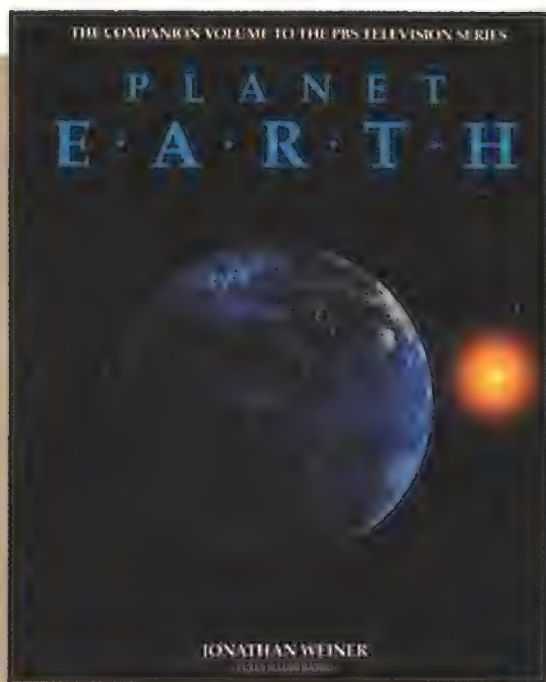
One wonders why the German pilots, who profess to be appalled by the Holocaust, pursue their revenge wearing swastikas, and why Lowen consents to meet them on their own terms. Unkefer takes a few stabs at explaining the pilots' motivations. One of them says, "It's something I know I have to do." But at heart, the author is more interested in portraying dogfights than pursuing character analysis.

Early in the book Unkefer writes, "Whatever grim chivalry once existed in mortal combat above the clouds had faded, nearly gone away." Unkefer revives that spirit as his flying aces take to the sky for their final confrontation.

—Daniel Stashower is a writer for *Time-Life Books*.

Planet Earth. By Jonathan Weiner. Bantam Books, 1986. 370 pp., photographs, \$24.95 (hardbound).

The publishers of *Planet Earth* bill their book as "The companion volume to the PBS television series." That, for better and for worse, is precisely what it is. Mostly it's for better: the book is beautiful, lavishly illustrated with intriguing computer images and spectacular color photographs. In easily digestible chapters, Jonathan Weiner (former senior editor of the New York Academy of Sciences magazine, *The Sciences*) describes the revolutionary changes deep-sea ex-



Planet Earth can be judged by its cover.

ploration and distant space probes have wrought in the earth sciences, and gives a coherent summary of where these manifold sciences—oceanography, climatology, cosmology, paleontology, evolutionary biology, and others—stand today. The science is intermingled with enough anecdotes and personality profiles to keep the attention of almost any reader.

At times, however, *Planet Earth's* close relationship to the television series detracts from the book. Chapters tend to repeat concepts, even explanatory analogies (“like a pot of boiling water” recurs to the point of ridiculousness), just as segments of television programs do (“For those of you who missed our last show . . .”). And, while television viewers can hardly expect to learn much about the filming of the images that flash across their screens, it is unfortunate that readers are not given more information about the making of this book’s photographs—or even, in some cases, an idea of their scale.

There are a few ways in which *Planet Earth* is better than any television series could ever be. For one thing, it has an index, and a thorough one at that. There is also a nine-page bibliography, organized by chapter and occasionally annotated (one book, for example, is described as “a literate and spirited introduction to modern geology,” while another is “a potpourri of articles and essays; beautifully illustrated”), for those inspired to learn more. And finally, there is the fact that the book is an object, something to put on a shelf or coffee table, something to treasure. And this is a book worth treasuring, both for its beauty and for the information it contains.

—Katie Janssen

SpaceCamp.

Twentieth Century Fox Film Corporation.
Premieres June 6.

If you’re looking for a fun summer movie with a spacey theme, you need look no further than your local theater listing for *SpaceCamp*. The movie follows the adventures of five teenagers (including Lea Thompson, of *Back to the Future* fame), who spend a summer at a camp for young space enthusiasts and wind up taking an unexpected trip into space.

Their camp instructor, Andy, is an astronaut, played by *Indiana Jones and the Temple of Doom* heroine Kate Capshaw. (Apparently, Hollywood does not yet feel comfortable giving traditional women’s names to women in non-traditional roles: the female flight instructor in *Top Gun* was named Charlie, and now we have woman astronaut Andy. Will lady-pilot Pete be next?)

The camp is closely modeled on the popular United States Space Camp at the Alabama Space and Rocket Center in Huntsville, Alabama, and much of the first half of the movie was filmed at the camp. Sessions at the U.S. Space Camp are only one week long in real life, but on the whole the movie reflects life at the camp accurately.

SpaceCamp director Harry Winer and co-producer Patrick Bailey both stayed at the U.S. Space Camp before shooting for the movie began. Edward O. Buckbee, director of the Space and Rocket Center, says that the movie “captures the essence of the U.S. Space Camp, and our emphasis on teamwork, very well. The movie follows through on the team concept and uses that as a major part of the story.” The movie also gives would-be Space Campers a sneak preview of the kinds of activities and facilities available at the U.S. Space Camp.

As the finale of their camp session, Andy and her five campers take a field trip to Cape Canaveral. (This field trip is *not* a regular activity at the U.S. Space Camp.) There, the six of them are invited to sit on board the space shuttle *Atlantis* while its engines are test-fired. And guess what happens? Right.

Actually, the movie does give an explanation for the unforeseen launch. Buckbee calls this explanation, “fictional but nevertheless credible,” which is true—but let’s emphasize that word “fictional.” And let’s just say that a rambunctious robot named Jinx has a lot to do with it.

While the plot device that puts our six stars in orbit may stretch the imagination, the portrayal of their launch does not. That’s because all the film is authentic. The movie combines footage from the Smithsonian Institution and Kennedy Space Center

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ABC Motion Pictures, Inc.



SpaceCamp stars spend a summer they won't forget learning about space.

archives with sequences *SpaceCamp* film crews shot of the June 1985 launch of the shuttle *Discovery*, and a test last fall of the shuttle *Atlantis*'s engines.

Shots of the campers inside the shuttle were filmed in a Los Angeles studio, using a detailed model of the shuttle orbiter. Winer claims that, "When Sally Ride came to visit the set she was quite astonished and thrilled with our model."

Meanwhile, back in orbit, Winer says of the campers, "Their horror during the launch turns to wonder as they encounter the weightlessness of space and the beauty of the view of Earth from space."

Simulating this weightless environment proved to be, in Winer's words, "the most difficult challenge of the whole show." While makers of other space movies have avoided portraying weightlessness (think about it: how *does* Luke Skywalker manage always to keep his feet on the ground?), the *SpaceCamp* set for the shuttle was actually an ingenious feat of Hollywood engineering that produced one of the best approximations of weightlessness you're likely to see on the silver screen.

SpaceCamp is good light entertainment, and a great way to get an inside look at the U.S. Space Camp.

Then again, you might do better to save your money for your own session at the real Space Camp. —Katie Janssen

On the Wing. *Funded by the Smithsonian Institution and Johnson Wax Company. Francis Thompson, Inc., Producer. Premieres June 20, National Air and Space Museum.*

It's no wonder that man has long felt the urge to fly, with such a variety of examples around him. From the graceful gliding flight of the eagle to the fast-paced beat of a dragonfly's transparent wings, nature has provided us with a multitude of aerodynamic inspirations. These inspirations, and man's response, are demonstrated in *On the*

Wing, the latest IMAX film.

Produced by Francis Thompson, Inc., the filmmaking company responsible for the popular *To Fly* and *Living Planet* large-screen IMAX films, *On the Wing* explores the relationship between man's first faltering attempts to fly and nature's vastly superior engineering—as well as our later successes. The IMAX format allows for some stunning footage of scenes from nature, such as the rush-hour explosion of millions of bats from a New Mexico cave, and slow-motion film of a condor soaring high over a Peruvian canyon. Mankind's flights provide for some equally breathtaking moments, including the dignified bulk of a Boeing 747 airliner in flight over Washington's Cascade Range and a pilot's-eye view of an 800-mph jaunt in a supersonic Lear jet through Arizona's Monument Valley.

But the real star of the film is the product of a unique creative collaboration between man and nature, a half-scale flying model of the largest airborne creature known to man. The footage of the recreated extinct pterosaur *Quetzalcoatlus northropi* cruising serenely over California's Death Valley sends the viewer back in time 200 million years, to a scene never witnessed by any human. (For details on the construction of the pterosaur, see "In the Museum," page 24.)

Mother Nature has been a frequent flyer for millions of years, but only in the last few hundred have humans tried to follow in her

footsteps. In a series of historical recreations, *On the Wing* replays some of our first tentative steps. Beginning with the sixteenth-century invention of the kite in China, the film moves ahead to a medieval European setting, as an unlucky inventor leaps from a castle's battlements with eagle-inspired wings strapped to his back, only to plunge through a henhouse roof. And in nineteenth-century England, Sir George Cayley's coachman takes a short but adrenaline-inducing ride in his master's glider, and resigns his position as soon as he returns to earth.

But man's flying schemes really got off the ground with the Wright brothers, and *On the Wing* recreates their experiments with gliders on the sand dunes at Kitty Hawk, and also their first powered flight on December 17, 1903. As the oddly graceful Wright Flyer reaches the end of its track and lifts into the air . . . the film jumps to the jet roaring through Monument Valley. Aviation has come a long way since those Chinese kites.

On the Wing presents its message during a scene near the end. As a hang glider soars over the French Alps, 6,000 feet above the ground, the pilot is joined by a golden eagle. The great bird circles ever closer to its hang-gliding master, finally alighting on his outstretched arm. The two ride the air currents together: man and nature are one in the clouds.

—Tom Huntington

A would-be aviator enjoys his brief moment On the Wing.

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A song.

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on our own government policy and on the moral conscience of our own citizens.

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Credits & Further Reading

Ariane. Alfred Meyer is a Washington-based novelist, editor, and journalist.

Further Information: "Ariane and Arianespace" by Douglas Heydon in *International Space Business Review*, Vol. 1, No. 1, June/July, 1985.

For more information on Arianespace, write to Arianespace, Inc., 1747 Pennsylvania Ave. N.W., Washington, D.C. 20006, (202)728-9075.

Arianespace on the Move. David Dickson, who lives in France, is the European correspondent for *Science* magazine.

The Battle of Bowman. Carl A. Posey is an information officer at the National Optical Astronomy Observatories. He lives in Tucson, Arizona, and writes frequently on science and aviation. His next novel, *Red Danube*, will be published by St. Martin's Press in August.

Further Information: *Weather and Climate Modification* by Wilmot N. Hess (Wiley, New York, 1974).

Who is Bryan Allen? Although an experienced pilot and once-avid bicyclist, *Stephan Wilkinson* has never pedaled an airplane. His writing credits include screenplays for three Academy Award-nominated documentaries.

Further Information: *Gossamer Odyssey: The Triumph of Human-Powered Flight* by Martin Grosser (Houghton-Mifflin, New York, 1981).

Airline Deregulation is Working. Joan Feldman is a Washington-based journalist and consultant in transportation matters.

Further Information: *Deregulating the Airlines*, edited by Elizabeth E. Bailey, David R. Graham, and Daniel P. Kaplan (MIT Press, Cambridge, 1985).

Deregulation: Increased Competition is Making Airlines More Efficient and Responsive to Consumers (General Accounting Office, Washington, GAO/RCED-86-26, November 6, 1985).

Deregulation and the New Airline Entrepreneurs by John R. Meyer and Clifton V. Oster, Jr. (MIT Press, Cambridge, 1984).

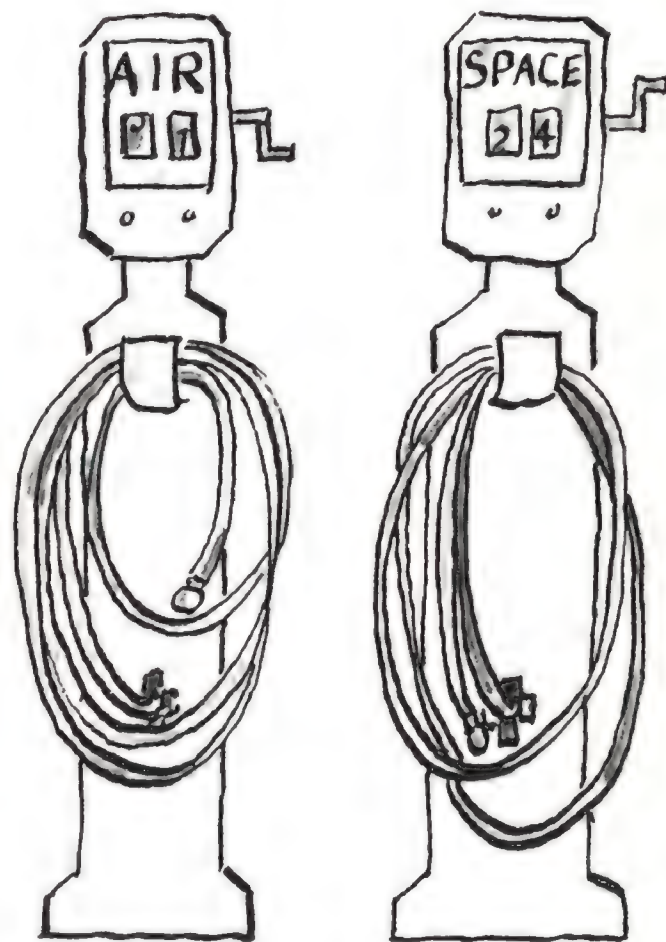
When Boats Flew. Capt. Richard Knott (Ret.) is a naval aviator whose flying time includes 1,000 hours in Martin Mariners. The author of two books on flying boats, he lives in Fairfax, Virginia.

Further Information: *The American Flying Boat* by Richard Knott (Naval Institute Press, Annapolis, 1979).

Black Cat Raiders of World War II by Richard Knott (Nautical and Aviation Publishing Company of America, Annapolis, 1979).

Flying Boats and Seaplanes Since 1910 by Kenneth Munson (MacMillan, New York, 1971).

Dollars from Heaven. Phil Cohan, a freelance writer, is a former Washington newsman and a veteran of the U.S. Foreign Service. His star is in the constellation Virgo.



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Further Information: Special issue on "Commercialization of Space," *Aviation Week and Space Technology*, Vol. 120, No. 26, June 25, 1984.

"Entrepreneurs in Space" by Stanley N. Wellborn in *U.S. News and World Report*, Vol. 98, No. 8, March 4, 1985.

"NASA Looks for Ways of Boosting Business Into Orbit" in *The Economist*, Vol. 292, No. 7353, August 4, 1984.

Bioflight. Michael Rozek lives in Spokane, Washington, where he has written for such publications as *Esquire*, *Sports Illustrated*, and *Rolling Stone*.

Further Information: *How Do You Go to the Bathroom in Space?* by William R. Pogue (Tom Doherty Associates, New York, 1985).

Richard Tousey and His Beady-Eyed V-2s. David DeVorkin is the chairman of the Space Science and Exploration Department at the National Air and Space Museum. He lives in Kensington, Maryland.

Further Information: *Beyond the Atmosphere: Early Years of Space Science* by Homer E. Newell (National Aeronautics and Space Administration, 1980).

Reaching Out, Reaching In. Pam Hait is a freelance writer who lives in Paradise Valley, Arizona, with her husband, two teenagers, a horse, a dog, and a snake. She attended the April 1985 launch of the space shuttle *Discovery*.

Further Information: *Hopi* by Susanne and Jake Page (Harry N. Abrams, Inc., New York, 1982).

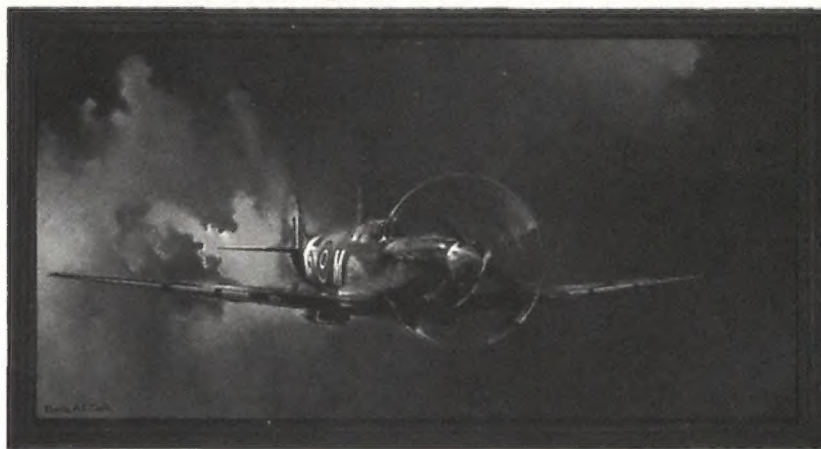
The exclusive agent for Dan Namingha is the Gallery Wall, 7501 5th Ave., Scottsdale, Arizona, 85251, (602) 990-9110.

Dark Flight. Fred Reed is a military and science columnist for the *Washington Times*. He has also written on military and general subjects for *Harper's* and the *National Review*. Reed served in the Marine Corps at Danang and covered Southeast Asia from Phnom Penh and Saigon for *Army Times*.

The Crowded Sky. Edwards Park was one of the founding editors of *Smithsonian* magazine. A former fighter pilot, he makes it a habit not to fly with spiders, snakes, and other non-mammals.

Space: Speak to the Soul. A scientist by training and a journalist by profession, Allen L. Hammond is editor of *Science* 86.

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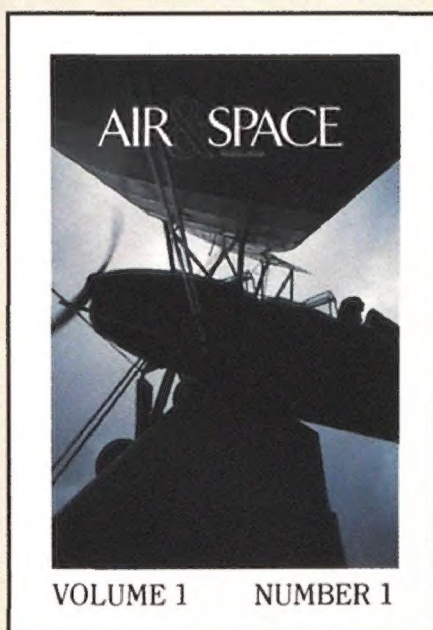
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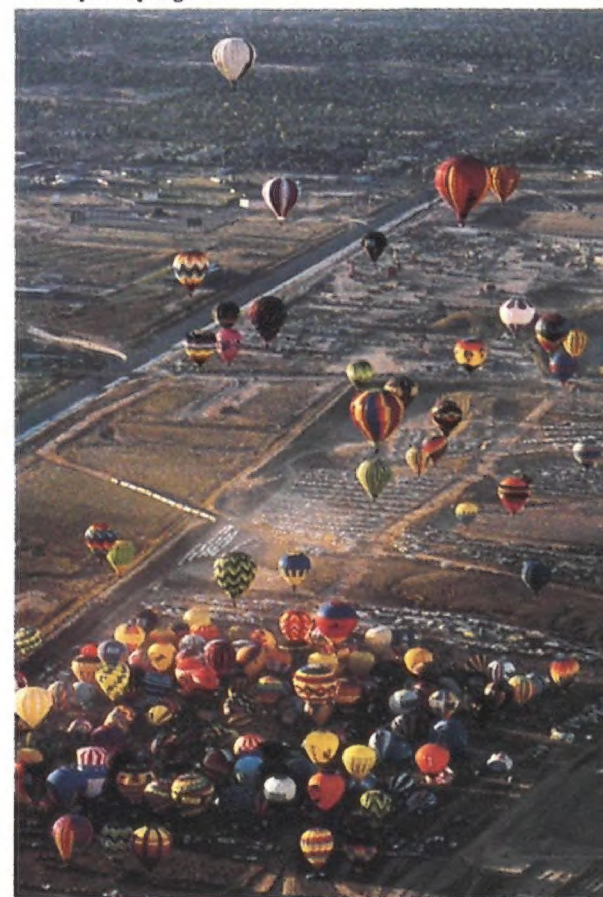


Aviation Poster Art— Sometimes realistic, sometimes fanciful, these depictions of aircraft and aviation lore by commercial artists merged images combining the popular sense of romance with the mysteries of a new science.

The Big, Bright World of Balloons— Nothing in the air is quite like a hot-air balloon, from the *Fwoosh!* of its gas-burners to its wicker-basket “cabin.” And when balloonists from around the world gather to fly together, the air seems festooned with the pure beauty of form and color.

The Rough and Ready Early Birds of New Guinea— During the gold-rush days, only airplanes could leap the miles of jungle to supply New Guinea’s early miners. It took hardy pilots and even harder airplanes to endure the hazards of this unique brand of pioneer flying.

Christopher Springmann



Gwynn-Jones Collection



Dry-feet Oceanography— Satellites are changing the way scientists study three-quarters of the Earth’s surface. Their new views of the oceans will yield such rewards as improved weather forecasts.

Happy Birthday, Moon— It dances in intimate bond with the Earth, yet only recently have scientists begun to reach some tentative agreement on how the moon was created: out of cataclysm.

Knock gets an airport— A parish priest in this Ireland town decided the place could use an international jetport.

Project Orbis— Put a complete surgical suite in a jetliner and fly it around the world—there’s nothing like bringing the hospital to the patients.

An aircraft carrier . . . made of ice!— No joke, this project actually went as far as testing a scale model during World War II.

THE VOLVO BOOK OF RECORDS.



Highest mileage for a Volvo still on the road.
Mr. Irv Gordon of East Patchogue, Long Island has clocked 909,000 miles on his 1966 Volvo P1800. Right on his tail is Mr. Norbert Lyssy of Vanderpool, Texas, with 902,000 miles.



Fastest round-the-world trip.
The fastest circumnavigation (24,901 miles) was completed on November 19, 1980 in 74 days 1 hour and 11 minutes by Garry Sowerby and Ken Langley of Canada in a Volvo 245.

Most Volvos in one family.
At last count, the Mozer family of Sea Cliff, New York, had bought a total of 12 Volvos since 1970.

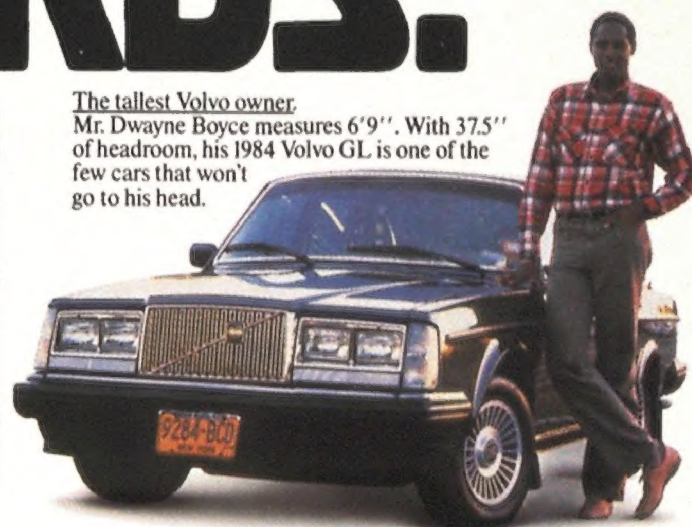


One of the top patents in the world.
Nils Bohlin's three-point safety belt design for Volvo (1959) was named one of the world's eight most important patents at the International Patent Conference in Munich, Germany in 1983.



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The tallest Volvo owner.
Mr. Dwayne Boyce measures 6'9". With 37.5" of headroom, his 1984 Volvo GL is one of the few cars that won't go to his head.



The most Volvos ever stacked on top of a Volvo.
The first known case of 'Volvo Stacking' took place in Mobile, Alabama in late 1971. Six Volvo 144s were stacked on top of another Volvo 144. This demonstration of Volvo's strength was recently repeated in Goteborg, Sweden, when six Volvo 760's were stacked on top of a new Volvo 760 Station Wagon.



The oldest Volvo in America. A 1936 Carioca PV36 owned by Charles Cunningham, a self professed Volvo connoisseur, of Topsham, Maine.

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